THE MONTHLY

Review

A. E. S. CONVENTION

and

INDUSTRIAL FINISHING EXPOSITION

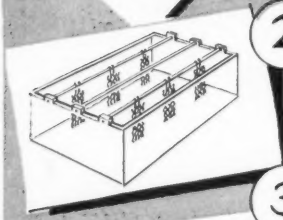
Detroit, Michigan — June 23-27

MAY • • • 1947

CLEPO'S Big 3
FOR THE PLATING ROOM
NOW ADD A *FOURTH*

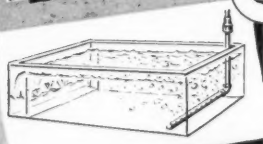
1 CLEPO CLEANERS

The best Cleaners to use in your Cleaning tanks.



2 CLEPANODES

The best Electrode to use in Electrocleaner tanks.



3 B-C RINSE AGITATORS

For more efficient rinsing —especially where rinsing time is short.

AND NOW

4 *Boque*

Water perfecting units for softening waters used in plating rooms.

Detailed information will be mailed to you immediately upon request from you on your company letterhead.

FREDERICK **GUMM** *Chemical Company Inc.*

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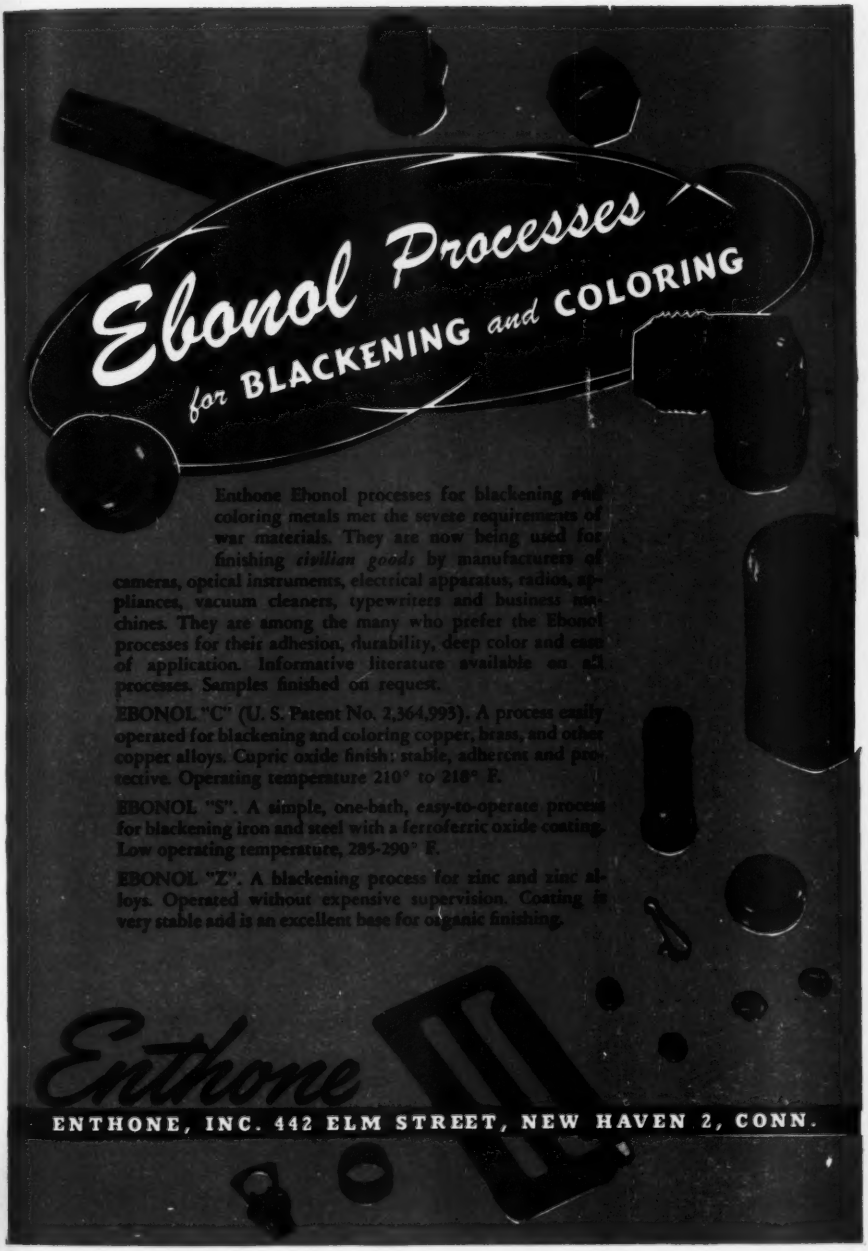
Ebonol Processes
for BLACKENING and COLORING
Enthone Ebonol processes for blackening and coloring metals met the severe requirements of war materials. They are now being used for finishing *civilian goods* by manufacturers of cameras, optical instruments, electrical apparatus, radios, appliances, vacuum cleaners, typewriters and business machines. They are among the many who prefer the Ebonol processes for their adhesion, durability, deep color and ease of application. Informative literature available on all processes. Samples finished on request.
EBONOL "C" (U. S. Patent No. 2,364,993). A process easily operated for blackening and coloring copper, brass, and other copper alloys. Cupric oxide finish: stable, adherent and protective. Operating temperature 210° to 218° F.
EBONOL "S". A simple, one-bath, easy-to-operate process for blackening iron and steel with a ferroferric oxide coating. Low operating temperature, 285-290° F.
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ENTHONE, INC. 442 ELM STREET, NEW HAVEN 2, CONN.

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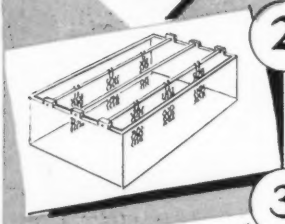

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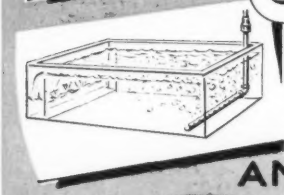

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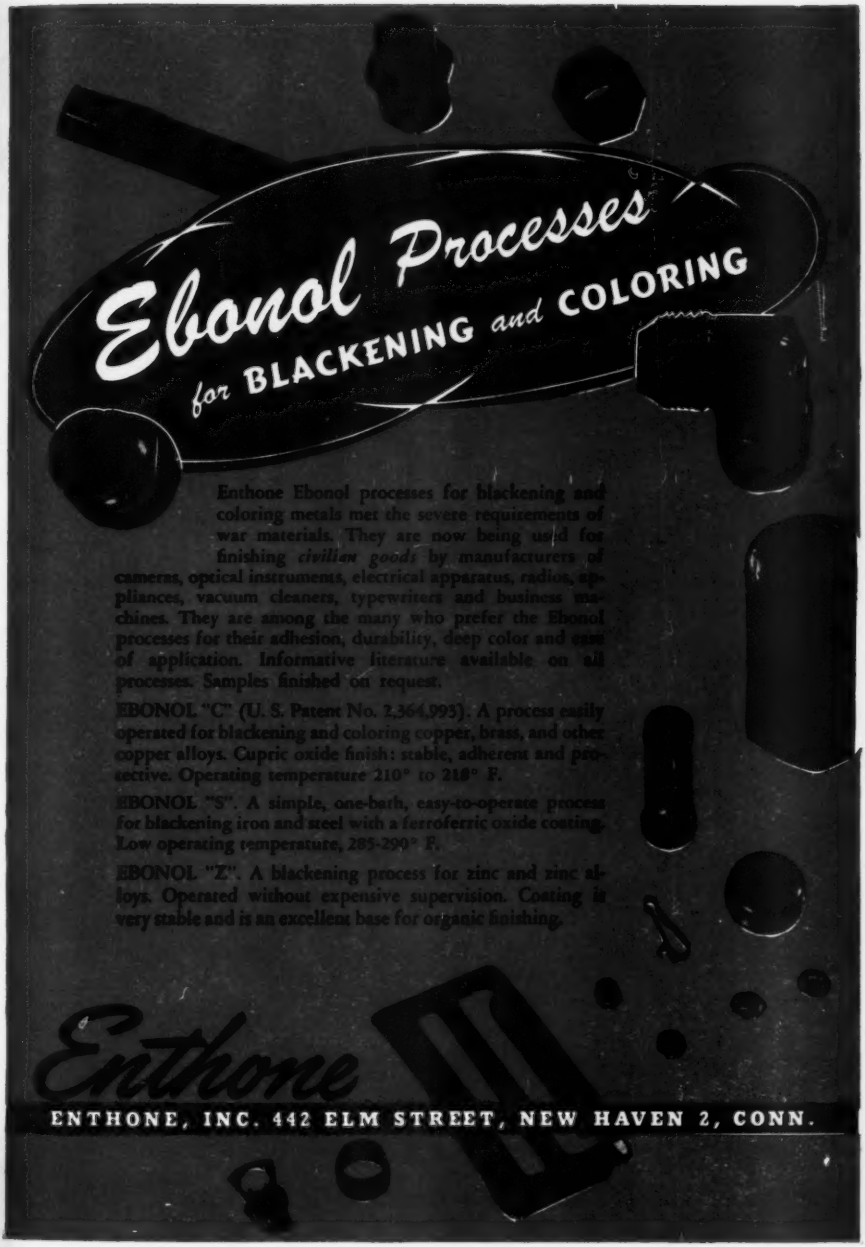
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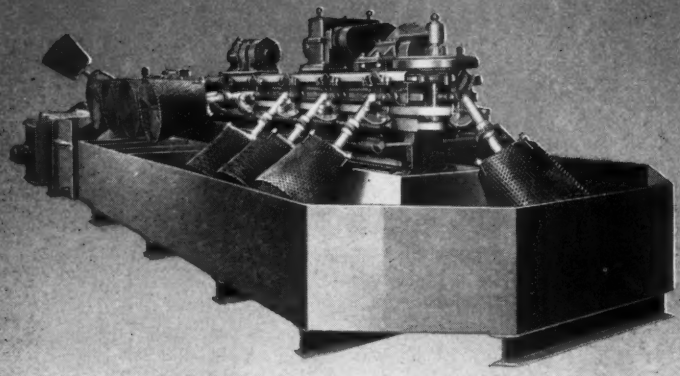
See It at the Detroit Exposition

WELCOME A. E. S.



DETROIT · 1947

STEVENS "STANDARD" SMALL PARTS PLATING MACHINE

This machine, which will be exhibited at our booths (Numbers 31 to 37 and 52 to 58) at the June Exposition of the American Electroplaters' Society, is a standard, complete Full Automatic Small Parts or Barrel Plating Unit, built to meet the popular demand for a medium sized automatic installation.

Cleaning, acid treatment, rinses, plating, drying and automatic unloading operations are all incorporated in this machine.

Can be used for cadmium, zinc, copper, nickel or tin plating of small parts. Wide variations in the plating cycle can be had instantly by means of fully developed method of control.

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No overhead construction. Overhead hoists and duck boards eliminated, low operating and maintenance cost.

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Entered as second class matter July 1, 1946, at the post office at Philadelphia, Pa., under Act of August 24, 1912.

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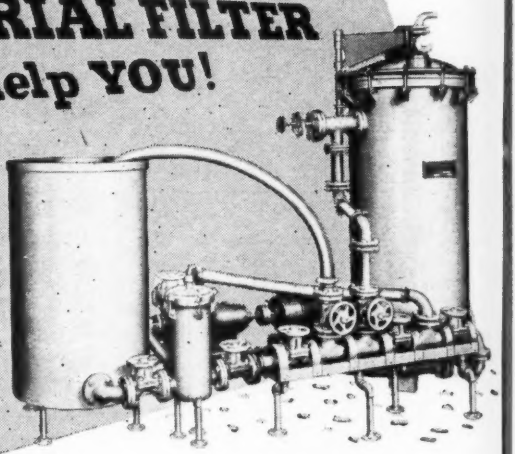
- Cut your plating costs
- Speed up production
- Produce quality plating
- Eliminate numerous plating troubles



Only CLEAN plating solutions can produce clean, non-porous plated coatings. The low cost for clarifying plating solutions with INDUSTRIAL FILTERS is really a saving as rejects are reduced and quality is greatly improved. Continuous clarification (filtering) also creates a beneficial circulation.

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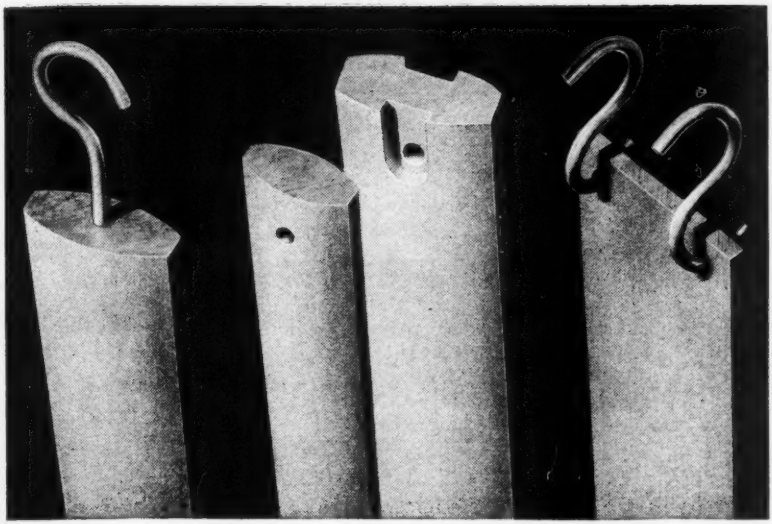

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WHEN YOU SPECIFY ANACONDA, you are assured of unexcelled purity... less than 0.01 percent of total metallic impurities... an advantage that pays off five ways:

1. **Copper goes into solution faster and more uniformly.**
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4. **Spotting and discoloration of the deposit are minimized.**
5. **Scrap losses are exceptionally low.**

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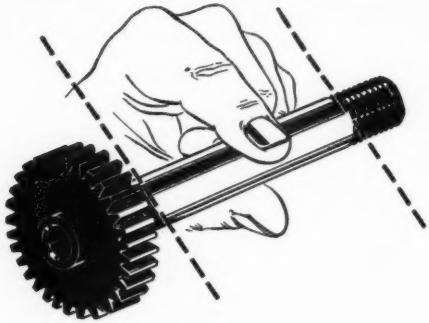
UNICHROME Stop-Off Compounds



help you do the fastest job on complicated shapes

DIPPED ON—these easily melted, waxlike materials speed production of your work with sharp edges or complex shapes. Coatings withstand severe plating solutions and cleaners; won't contaminate the bath.

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Trade Mark Reg. U. S. Pat. Off.

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F. B. 2610 Proof 2 4-3 Ad. No. 2414-55 Monthly Review, A E.S.—May

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Du Pont literature to help you with PLATING

Bulletin A-5087—Potassium High-Speed Copper (RH-661)

Bulletin A-4385—High-Speed Copper Plating Process (RH-553)

Bulletin A-5719—Electrotinning

Bulletin A-4555—Drop Tests for Zinc, Cadmium and Copper

Bulletin A-6613—"Zin-O-Lyte" Bright Zinc Plating Process

Bulletin A-6399—"Cadalyte" Cadmium Plating

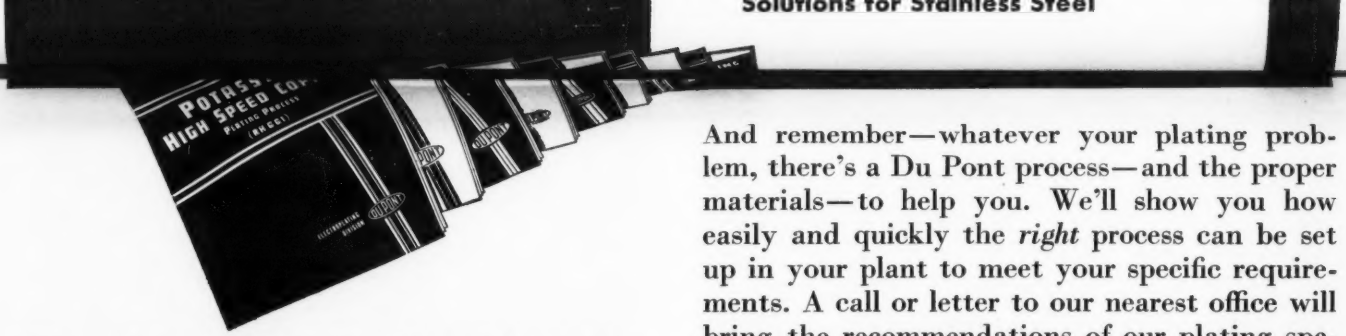
Bulletin A-5095—"Plating Test Control of Plating Baths"

Bulletin A-4636—Du Pont "Halogen Tin" for Continuous, Rapid Electrodeposition of Tin on Wire

Bulletin A-5717—"Durobrite" Zinc Plating Process

Bulletin El-Sol—Du Pont Electropolishing Solutions for Stainless Steel

Solutions for Stainless Steel



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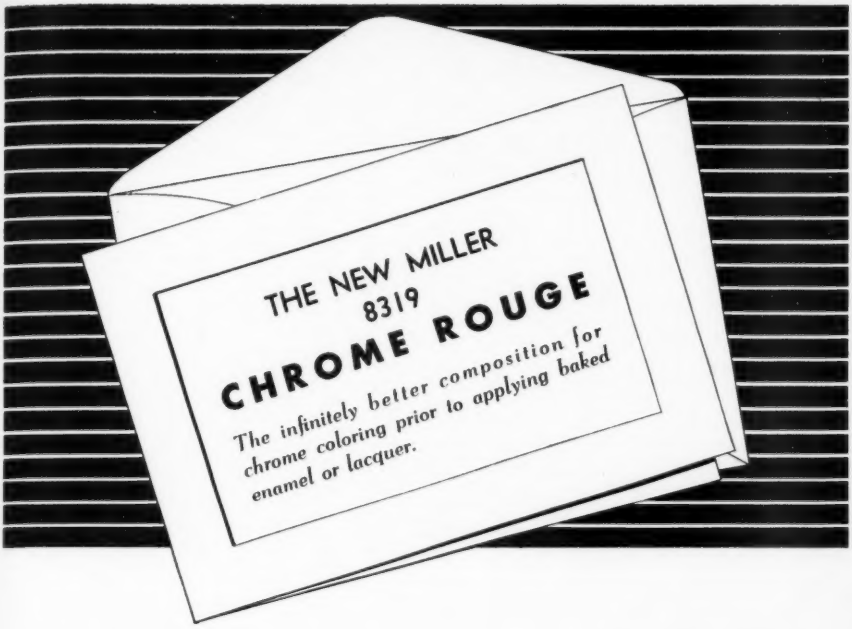
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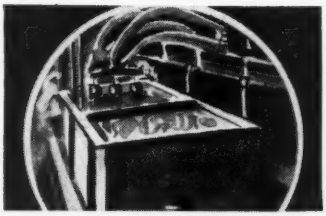

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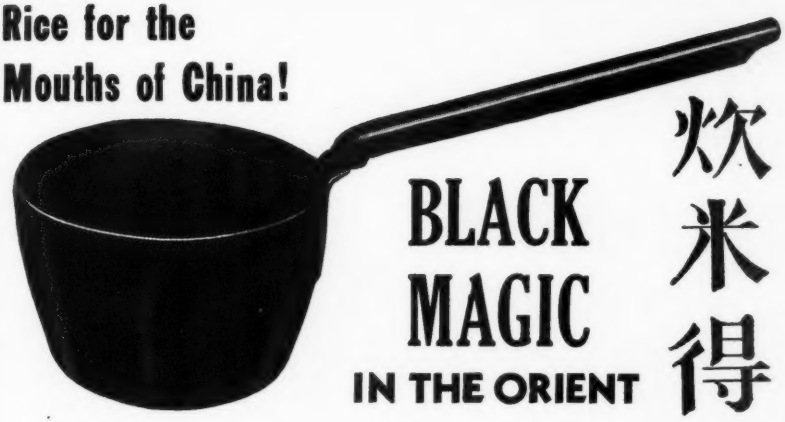

BLACK MAGIC IN THE ORIENT

炊米得福

This is a steel rice bowl designed for widespread use in China. To insure good corrosion resistance and attractive appearance at low cost, the manufacturer decided to standardize on a BLACK-MAGIC (black oxide) finish, plus a "Witch Oil" Final Finish.

This is but one of thousands of applications for BLACK-MAGIC. BLACK-MAGIC is more than a "blackener." It is an integral finish that penetrates to .0001". It is very flexible—forming may follow processing—often a big saving. It is also an excellent paint and lacquer bond. Chemical reaction takes place at 300° F. For all steels except stainless.

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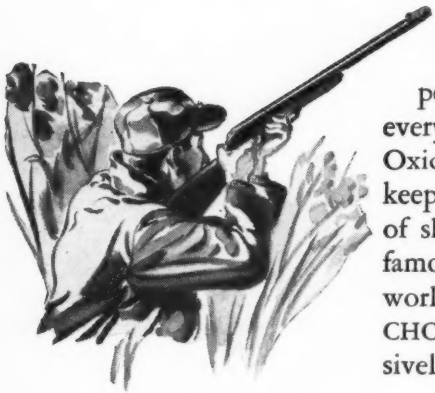

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ANODES

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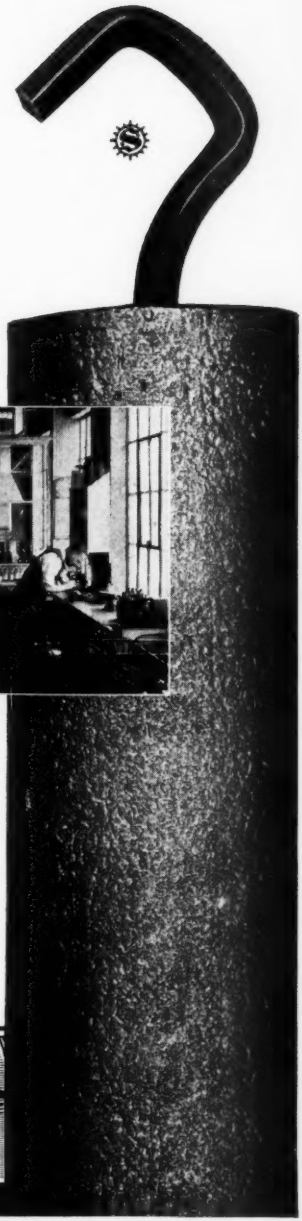
If you are struggling with some sort of plating difficulty, such as slow corrosion, excessive sludge, peeling, porosity, brittle deposit, etc., our well-equipped laboratory and experienced staff will gladly lend a hand. In this laboratory, chemists are constantly making analyses and tests — working out short cuts wherever possible, and doing other things of present or potential value to the plating industry. Their experience is yours whenever you choose to make use of it.



A HANDY LIST OF SEYMOUR ANODES

99%+ *Rolled Depolarized* — A very fine, homogeneous, even-grained virtually pure nickel anode. Corrodes in hot or cold solutions with minimum metallic loss. Forms practically no sludge. Especially suitable for baths having a pH above 4.5 electrometric.

99%+ *Rolled Carbon* — A rolled anode of high efficiency for low pH hot Watts baths not above 4.5 electrometric. Corrodes smoothly with a minimum of loose nickel.

99%+ *Cast Carbon* — A pure nickel anode with carbon content adjusted for smooth, uniform corrosion without special controls. Available, however, with carbon content to meet any specifications. Adaptable for general shop work using hot or cold baths.

95-97% *Sand Cast* — Corrodes readily in solutions low in nickel or weak in salts — therefore suitable for cold, high pH, low current density plating solutions. Uniform corrosion throughout the life of this anode is obtained by an even distribution of the carbon content. A 90-92% Sand Cast Seymour Nickel Anode is also available.

"Seycast" — An improved type of 99%+ cast anode of very high efficiency designed primarily for Bright Nickel baths, but works perfectly in any hot Watts bath having a pH of 4.5 electrometric or lower. Corrodes evenly with practically no loose nickel formation, due to long, interlocking grains radiating from a common center. Especially suitable for high current densities.

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OTHER ANODES — Seymour Anodes in all shapes to meet rigid specifications are also available in copper, brass, bronze and zinc. The copper used is electrolytic. The zinc is always the best grade obtainable.

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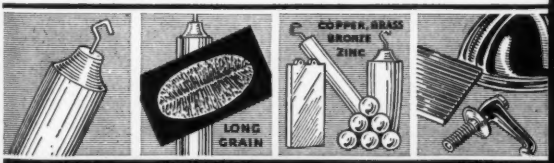
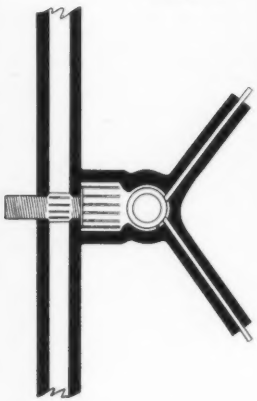


NICKEL ANODES | "SEYCAST" ANODES | OTHER ANODES | BRIGHT NICKEL

STANDARD

replaceable

tips



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And if specifications are changed on your parts or you want to use the rack for an entirely different part, merely interchange the tips with a new set to fit your new part.

That's how Standard replaceable tips cut your plating costs. It's another example of Standard's ability to build a better rack for your plating job. Take advantage of this cost-cutting feature the next time you order racks. Remember, "racks is our business."

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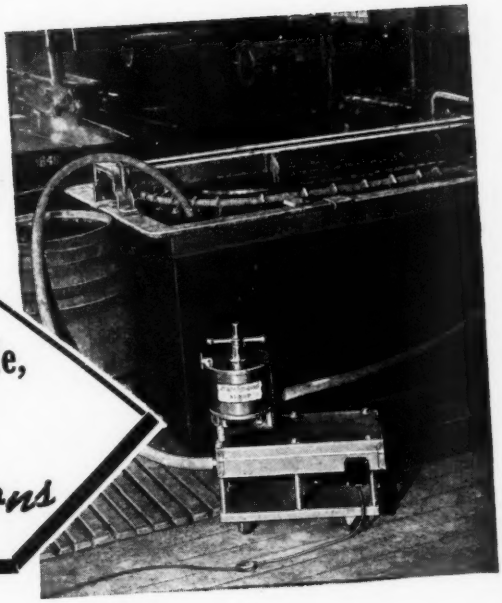
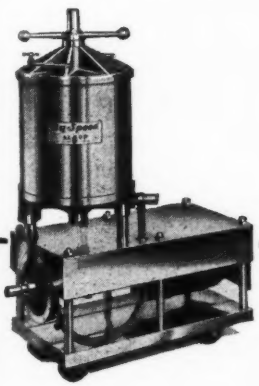


This compact, portable, positive filter for *Plating Solutions*

A real space and time-saver



Note how motor and pump are completely protected from damage caused by spilled or splashed corrosive liquids. This "Sealed-Disc" Filter is complete as shown, ready for instant use.

Where space is at a premium, and the removal of dirt, dust, oil and sludge from plating solutions must be accomplished simply and efficiently, you'll find the "Sealed-Disc" Filter ideal in every respect.

The "Sealed-Disc" Filter has proved itself so outstanding in so many installations large and small that platers everywhere consider them a must for perfectly finished work.

In their judgment, no other filter measures up in compactness, portability, simplicity and general efficiency. . . . WHAT'S MORE, "Sealed-Disc" Filters are capable of handling as large a volume of solution as conventional filters many times their size. They are completely enclosed, air-tight, eliminating loss of solution through leakage or dripping. Made in capacities from one gal. per minute up to thousands of gallons per hour. Filtering powders or slurry mixing tanks are not required.

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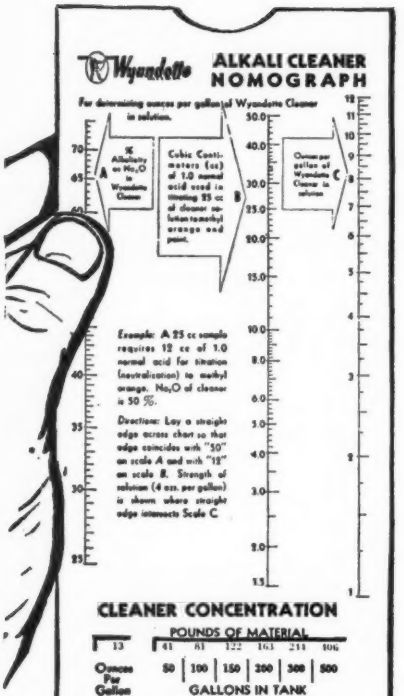
Wyandotte
ALKALI CLEANER NOMOGRAPH
For determining ounces per gallon of Wyandotte Cleaner in solution.
% Alkalinity as Na_2O in Wyandotte Cleaner
Cubic Centimeters (cc) of 1.0 normal acid used in titrating 25 cc of cleaner solution to methyl orange end point.
Ounces per gallon of Wyandotte Cleaner in solution
A
B
C
Example: A 25 cc sample requires 12 cc of 1.0 normal acid for titration (neutralization) to methyl orange. Na_2O of cleaner is 50 %.
Direction: Lay a straight edge across chart so that edge coincides with "50" on scale A and with "12" on scale B. Strength of solution (4 oz. per gallon) is shown where straight edge intersects Scale C
CLEANER CONCENTRATION
POUNDS OF MATERIAL
Ounces Per Gallon
50 100 150 200 300 500
GALLONS IN TANK
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Why

A NATIONAL ORGANIZATION?

Why a national organization? That question can properly be asked in view of the opinions of some members as to the probability of the officers dictating policy and controlling the functions of the entire organization. There is a belief on the part of some members that too many technical men have been elected as Officers of the Supreme Society. In the past the Delegates have elected the Officers. The delegates, in turn, were elected by the constituent membership of the Branches. There have been no restrictions whatever on the nominations. At no Convention has the closing of nominations been rushed. If the proposed Constitution is adopted, in the future the entire membership will vote directly on the A. E. S. Officers and have the right to nominate anyone. In the past and in the future the election of Officers is and will be the will of the majority.

The Society has been very fortunate in the selection of Officers as is evidenced not only by the surprising growth of the membership but by the amount of time that they have given, without personal compensation and frequently without sufficient expense allowances, to the objects of the Society as stated in the constitution: "The improvement and dissemination of the art and science of electrodeposition." No better proof can be had than the work of the Officers, especially in recent years, in establishing and directing the research policy of the Society.

Could men without a technical background, regardless of whether it had been obtained in a University or through burning the midnight candle, have conceived and brought to actual existence the present research program? Can any one Branch do the same job? Can advancement in the art and science of electrodeposition be made without a concrete knowledge of the technical problems involved? Could a plater, who may have spent his life in a plating room, conceive and develop the many new methods and processes which have come into being in the last twenty-five years? Bright nickel, high speed nickel, bright copper, high speed copper, bright zinc, cadmium, chromium, and many other processes were unknown in the production plating room within the memory of many young men.

When the electroplaters first organized a society, it was most difficult to get a paper for discussion. It took the example of Charles H. Proctor to break down the reticence of the plater. In the statement of the objects of the organization was the following: "The craftsmen or platers have labored incessantly to bring the trade to its present high standard. In most cases they have worked in the dark and by the 'rule of thumb,' with what inherent ability they possessed."[1]

At the meeting on November 6, 1907, the following action was taken: "After considerable discussion pro and con, it was finally voted to forbid the publication in any trade journal of any paper on plating subjects presented before the Association unless sanctioned by a two-thirds vote of members present."[2]

At the first banquet of the organization on January 16, 1910, Mr. Percy Brown, Secretary, presented a paper on "The Chemist's Relation to the Electroplating Industry." He stated what has proven to be a prophecy: "There seems to be a general impression among platers that the chemist is merely a theorist, and they are

[1] *Metal Industry*, p. 269, July 1909.
[2] *Metal Industru*, p. 422, Nov. 1909.

inclined to smile whenever a chemist attempts to show them some points about plating. This attitude is an unadvised one as the modern chemist is, as a rule, a specialist, and when he becomes interested in plating it is only a matter of a short time before he learns the practical points and becomes equipped to more than compete with the experienced platers. Electroplating is essentially an electrochemical process and, therefore, it is far easier for a chemist who knows the theory of electrolytic action to learn the practice of plating than for the practical plater to learn the theory. Eventually, the plater will be a chemist as a matter of self-protection, as otherwise he will find himself being replaced by the younger generation." That is, unfortunately, as true today in the thinking and, in some cases, in the action of some platers regarding the Officers of the Supreme Society and, also, in their unthinking discussion of the proposed Constituion. Mr. Brown continued: "If we credit where credit is due, we will find that the greatest advamces in electroplating have been made through the published researches of chemists and metallurgists or platers well versed in chemistry."[3]

At the same meeting, Mr. Charles Proctor said: "There are a few things that kill the spirit of cooperation in others in spite of anything. Unfortunately, we have, in our existence, experienced those things. One of them is the mood of a man who is everlast ingly looking for trouble . . . It is the intention of the Association, as soon as finances allow, to maintain a chemical laboratory for the benefit of its votaries."

Is not that being accomplished through the work of the Officers of the Supreme Society in obtaining funds from all who are interested in electroplating to carry on the splendid work of the research projects?

Our whole-hearted cooperation should be given the technical men who have given so much of their time to fulfill the prophecy of Proctor and Brown. What has been done and is being accomplished could not have become a reality through men who, unfortunately, have not had the opportunity for development in the science of chemistry, electrochemistry and metallurgy. The electroplaters need the aid of scientifically trained men. The Society is made up of both technical and practical men who need each other. The Society needs a Constitution which will bring about a full recognition by other scientific organizations and which will eliminate much of the obsolescence resulting from numerical growth and from greatly increased activity.

Like the nautilus, let us "Leave our low vaulted past and build a dome more vast." The object of the A. E. S. is "The Advancement." Just say to yourself, "Wher I was a child, I spake as a child, I understood as a child, I thought as a child; but when I became a man I put away childish things . . . now I know in part; but then I shall know even as I am known."

---

[3]*Metal Industry*, pp. 46–47, Jan. 1910.

George B. Hogaboom

DETROIT

JUNE 23 TO 27 INCLUSIVE

Industrial Finishing Exposition

AND

34TH ANNUAL CONVENTION

AMERICAN ELECTROPLATERS' SOCIETY

A. E. S. MEMBERS
PLANT EXECUTIVES
ENGINEERS · TECHNICIANS

This Exposition, the greatest of its kind ever held, is designed to acquaint the executive who ordinarily does not attend American Electroplaters' Society Conventions, with the latest developments in finishing equipment and the techniques of various processes.

Many of the exhibits will be in operation, thus affording an opportunity to actually see the forward strides this $300,000,000 industry has made in the past few years.

You will meet the men who are responsible for those new developments . . . to talk with them and obtain valuable information on new and up-to-date Equipment. Don't fail to attend this mammoth Exposition. You will find that it will pay worth-while dividends in knowledge gained and prove to be time well spent.

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A. E. S. CONVENTION
and
INDUSTRIAL FINISHING EXPOSITION
Detroit, Michigan — June 23-27

More than one hundred nationally known manufacturers from all parts of the country will exhibit the latest equipment, materials, services, processes, and plated products at the Industrial Finishing Exposition.

One of the outstanding educational features of the Industrial Finishing Exposition will be a *completely equipped plating installation* where souvenirs will be plated and given to Exposition visitors. This plating plant will consist of full-scale plant equipment and will be operated under normal plant conditions. It is believed that this particular exhibit will illustrate how plating procedures are conducted.

Fully automatic and semi-automatic plating processing machinery will be in operation in several booths. The exhibitors of this machinery will show full-scale production units.

Automatic polishing and buffing equipment will be in operation. In connection with this type of machinery, special emphasis will be laid on the application of buffing compounds. Both mechanical applicators and the latest spraying devices will be shown.

A graphic illustration of *the largest plating installation in the world* will be the feature of one important display. The complete operation of this huge plant will be shown in mural-style photographs and charts.

One of the most interesting developments to reach the electroplating industry in some time is the matter of "*current reversal*". This will be one of the feature attractions of a prominent display which will include recent developments in temperature, automatic fluid or solution level controls.

All of the important *generator and rectifier* manufacturers will have their products on display, and representatives will be present to explain the details of each product.

The *latest processes* in copper and nickel baths, as well as the new rust proofing solutions with their subsequent recent protective coating developments, will be there for investigation.

For those interested in the protection of the "plating room tool", the plating rack, *new rack coatings* will be displayed, as will *lacquers for special finishes.*

New *cleaning developments*, degreaser equipment and applications, complete *filter equipment* and accessories will be there for examination.

Safety engineers will be particularly interested in seeing new methods and ideas for the handling of acids and other materials for safeguarding employees.

Truly, the Industrial Finishing Exposition will be the mecca for A. E. S. members, process engineers and technicians, and all operating engineers and executives who will for the first time in over ten years have the opportunity of seeing, investigating, and discussing the up-to-date developments and ideas of the complete metal finishing industry.

For the membership of the American Electroplaters' Society, whose headquarters will be at the Statler Hotel, there will be additional features.

One of these features of the 34th Annual Convention of the American Electroplater's

A. E. S. CONVENTION 1947
TENTATIVE EDUCATIONAL PROGRAM

Dr. R. B. Saltonstall, Chairman of the Educational Committee of the Detroit Convention Committee, announces the following tentative technical program. Details of the program for the presentation of A. E. S. Research will appear in the June issue together with all other features of the Convention.

Monday, June 23

2:00 to 4:30 P. M.—First Educational Session

1. *Stress in Electrodeposits and Its Significance*—K. G. Soderberg and A. K. Graham
2. *Stress in Electrodeposited Nickel*—William Phillips and F. L. Clifton
3. *Physical Properties of Electrodeposited Chromium*—Abner Brenner, Polly Burkhead and Charles W. Jennings
4. *To be announced*

Tuesday, June 24

9:00 to 11:30 A. M.—Second Educational Session

1. *Modern Applications of Electroplating Solution Purification*—B. C. Case
2. *Electroforming Pitot Static Tubes*—Alfred S. Kasdan
3. *Chemical Deposition of Nickel and Cobalt*—Abner Brenner and Grace Riddell
4. *Recent Developments in the Use of Conversion Coatings on Zinc*—J. E. Starek and W. S. Cibulskis
5. *Bulk Nickel Plating*—Henry Strow

Wednesday, June 25

9:30 to 12:00 Noon—Third Educational Session

1. *Manufacturing Process for Standard Sixty-Inch Reflector*, a Sound Film in Color—Engineer Board, Ft. Belvoir, Va.
2. *Barrel Chromium Plating*—G. Dubpernell and S. M. Martin
3. *An Industrial Hygienist on Chromium Plating*—J. E. Molas
4. *Standardization of Buffing for Preparation of Atmospheric Exposure Test Panels*—C. C. Cupps and A. K. Graham
5. *Evaluation of Buffability of Nickel Deposits*—R. D. Miller and A. H. Du Rose

2:30 to 5:00 P. M.—Fourth Educational Session

A. E. S. Research

Thursday, June 26

9:30 A. M. to 12:00 Noon—Fifth Educational Session

A. E. S. Research, continued

Society will be the Society *Branch exhibits* which will be located at the Statler Hotel Convention Headquarters.

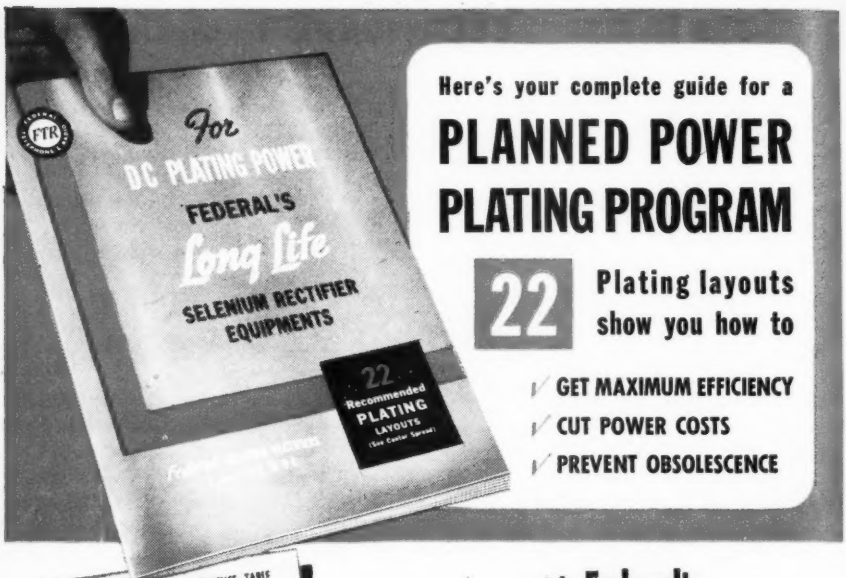
All arrangements for these exhibits are being handled by Mr. Arthur Logozzo, Branch Exhibits Chairman, Supreme Third Vice-President of the Society, who can be reached at his business address, the Nutmeg Chrome Corporation, 79 Chapel Street, Hartford, Conn.

The various nationally known plants under consideration for plant visitation on Friday, June 27, are:

Chevrolet Bumper Division, Detroit, Mich.
Cadillac Motor Division, Detroit, Mich.
Ford Motor Company, Detroit, Mich.
Fisher Body-Ternstedt Division, Detroit, Mich.
Pontiac Motor Division, Pontiac, Mich.
United States Rubber Company, Detroit, Mich.
Wyandotte Chemicals Corporation, Wyandotte, Mich.

Hooker Kresge Library, located at Wayne University in Detroit, will be available to

(*Continued on page 563*)



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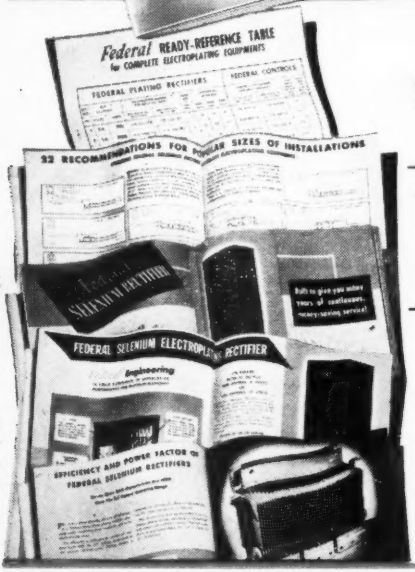
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for COMPLETE ELECTROPLATING EQUIPMENTS
22 RECOMMENDATIONS FOR POPULAR SIZES OF INSTALLATIONS
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COPPER PLATING IN ALKANESULFONIC ACID BATHS

C. L. Faust *B. Agruss* *E. L. Combs*
BATTELLE MEMORIAL INSTITUTE

Wayne A. Proell
STANDARD OIL COMPANY (INDIANA)

ABSTRACT

Plating conditions are described for depositing copper at current densities of 60 to 1000 asf from baths based on a new class of strong acids, alkanesulfonic acids. Semibright plate is deposited without the need for addition agents, and it, as well as matte plate, is easily color buffed on wheels or electrolytically. Bright nickel, deposited directly over the semibright copper, has good color. Acceptability of the as plated deposit would depend on the application involved.

The effect of variation in operating factors, as reflected in plating results, is discussed for four sets of plating ranges:

A dilute bath operating at current densities—about 60 asf—most generally available with present-day installed equipment.

A bath for plating at faster rate than generally used in decorative or protective plating, but still commercially feasible—about 200 asf.

A bath for depositing semibright plate, having "luster" at practically feasible current density—about 150 asf —without addition agents.

A bath for plating at current densities up to 1000 asf with simple agitation.

INTRODUCTION

A class of strong acids new to industry is under development by the Standard Oil Company (Indiana). These are alkanesulfonic acids of methane, ethane, propane, and butane. Metal salts (including silver and lead salts) of these acids are soluble in aqueous solutions and appear to be highly ionized. Preliminary experiments indicated that unusual potentialities existed for electroplating solutions based on alkanesulfonic acids. Alkanesulfonic acid salt solutions of most of the commonly plated metals yield a fair deposit on electrolysis. Exploration of these was undertaken for Standard Oil Company (Indiana) at Battelle Memorial Institute. This paper is to report a part of the results from the plating research. The program has yet not been completed, but the details remaining to be worked out relate to improvements and do not detract from the interesting features revealed herein.

Identity of Alkanesulfonic Acids

These acids are monobasic in their reaction to form metal salts and have the general formula

$$R\,SO_3H$$

in which R is a methyl, CH_3; ethyl, C_2H_5; propyl, C_3H_7; butyl, C_4H_9; etc., group. They are strong acids, and are liquids miscible with water. When pure, the acids are thermally stable to above 100° C, and in dilute water solution they can be boiled for weeks without a trace of decomposition. Aqueous solutions of the metal salts appear to have a mild degree of inherent surface activity and, in general, the plates obtained from almost all metal alkanesulfonate solutions are different in character from those from

simple inorganic salts. Plates tend to be smoother and modified in crystal structure.

For the present work on copper plating, mixed alkanesulfonic acid was used. Such a mixture is predominantly methane, ethane, and propanesulfonic acids.

A typical property listing would include: sp. gr. 1.35; normality 12.08*; 92.7 per cent mixed alkanesulfonic acid (average molecular weight 113), 3.2 per cent H_2SO_4, 4.1 per cent water. A 1 per cent solution has a *p*H of about 1.15.

The interesting faculty of these acids to form exceptionally water soluble salts is shown in Table I.

TABLE I

Solubility of Salts of Alkanesulfonic Acids

Acid	Solubility at 28° C g/100 cc water	
	Barium Salt	Lead Salt
Methanesulfonic.....	68	144
Ethanesulfonic.....	81	206

EXPERIMENTAL

Preparation of the Plating Baths

In preparing the baths for this study, the requisite weight of acid was diluted with water to approximately three-fourths the required volume. The requisite weight of c.p. basic cupric carbonate was added to the acid solution as a slurry, slowly and with stirring.

The weight of cupric carbonate was calculated as

$$\frac{(\text{g/l copper}) \times (\text{liters of bath}) \times (1.03)}{\%\ \text{copper in cupric carbonate}}$$

The extra 3 per cent copper, indicated in the above calculation (1.03), is necessary to replace the copper precipitated during the dissolution of the cupric carbonate in the acid.

After all the cupric carbonate had dissolved, the bath was diluted to volume with distilled water. Then 20 g/l of Hyflo Super Cel† filter aid was stirred into the solution, and the bath was filtered. The filtered bath was treated with 12 g/l activated carbon (300 mesh) with vigorous stirring for 15 minutes at 150° F, and filtered again. This solution was then electrolyzed or "dummied," using brass or copper cathodes and copper anodes, at 60 asf and 120 to 150° F until 12 amp/hr/l of current had passed through the solution.

Any sludge or precipitate formed was filtered off. The copper and free acid were checked by analyses and corrected if necessary. The bath was then ready for plating.

If it was necessary to add copper carbonate in the bath, the stoichiometric quantity of acid was added also, to maintain the free acid value.

If, after a plating campaign, it was found necessary to add sulfonic acid, it did not appear necessary to "dummy" the bath again. However, the bath was given an activated carbon treatment, especially if a substantial amount of acid was added.

The bath was easily controlled by periodic chemical analyses for copper and free acid. Since the effect of free acid concentration was more critical than the copper content, the free acid was determined more frequently.

Procedure

The performance studies were carried out in nine one-liter baths. They contained 25, 50, and 100 g/l of copper, and for each copper concentration, baths containing 10, 25, and 50 g/l free acid were prepared by the procedure described in the preceding section.

Each plating cell had two copper anodes, 2 in. x 3 in. submerged area, one on each side of the cathode. The cathode was a soft brass panel, 1 in. x 3 in. submerged area.

Panels were cleaned as follows:

(a) Degrease in trichloroethylene

(b) Hot alkaline cleaner

30 g/l sodium metasilicate
7.5 g/l sodium hydroxide
0.5 g/l Duponol M.E.
2-minute soak at 180° F

*All normality and free acid determinations were made by titration with normal alkali solution to *p*H of 4.5 (glass electrode).

†Johns-Manville Company.

(c) Ammonium chloride-hydrochloric acid dip

150 g/l ammonium chloride
42 cc/l concentrated hydrochloric acid
1½-minute dip at 160° F

Plates approximately 0.001 inch thick were made in each bath at increasing current densities starting from 20 asf, at 90°, 120°, and 150° F. The current density, at which the first signs of "burning" were observed, was taken as the limiting current density. The limiting current density was confirmed by making a plate at a higher current density and noting the increase in "burned" area.

The cathode was given a slow reciprocal movement with the plane of the panel being parallel with the plane of the anodes and with the direction of motion. The movement consisted of a 2 inch stroke at 32 cycles per minute.

RESULTS

The composition of the plating baths and their operating characteristics are shown in Table II. The bath number has two components referring directly to g/l of copper and maximum g/l of free acid. For example, bath No. 25–10 contains 25 g/l of copper and 10 g/l maximum free acid.

The Most Dilute Bath and Its Operating Conditions

Plating in this bath, No. 25–10, is done at the nominal average current density of 60 asf, which is compatible with the capacity of most present-day plating installations. The bath temperature is maintained at 120° F or 150° F.

A very high factor of safety in the current density range exists for irregularly shaped objects on which the current density on some areas may vary considerably from the average for the whole part. The plates are smooth, pink, and matte, and become finer grained at current densities above 100 asf. The plates made at 60 asf have a hard crystal structure and require a fast, hard wheel for buffing. These plates have a textured appearance after electrobuffing. However, the 100 asf plates are readily buffed to a smooth surface by both methods.

The Median Concentration Bath Is Generally Operated for Faster Plating

The plates from this bath, No. 50–10, are smooth and fine grained at the nominal average current density of 150 asf. They are easily buffed by customary mechanical methods and by the electrolytic method. The latter reveals a somewhat "crystalline" appearance

TABLE II

Bath Composition and Operating Characteristics of Copper Alkanesulfonate Baths

Composition g/l	Bath No. 25–10	Bath No. 50–10	Bath No. 100–10
Basic cupric carbonate (55.5% Cu), g/l	45.1	90.1	180.2
Copper (as metal), g/l	25	50	100
Free alkanesulfonic acid, g/l	5–10	5–10	5–10
Operating Characteristics*			
Limiting current density† at 120° F, asf	150	350	700
Practical current density range at 120° F, asf	20–100	100–250	250–600
Limiting current density† at 150° F, asf	200	400	1200
Practical current density range at 150° F, asf	20–150	100–300	500–800
Cell voltage at 150° F	0.5–4.0	2.5–6.5	8.5–12.0
Ratio anode to cathode area	1:1	2:1	4:1

*With work rod movement = 2-inch stroke, 32 cycles/min.
†Limiting current density is defined as the maximum asf which gives satisfactory 0.001 inch plate

The Bath for "Lustrous" Plates

Successful operation of this bath, No. 100–10, requires more rigid control than the other three modifications selected. Both *temperature* and *current density* are important factors in maintaining a "lustrous" plate. When high ductility is not important, such as on die castings, current densities between 60 and 500 asf may be used at 90° F. Thus, at 90° F a wide range of current density is permissible, although the ductility of the plate is not high. For high ductility, temperatures of 120° F or 150° F must be chosen. However, at 120° F the current density range for "lustrous" plate is limited to 150 to 600 asf, and current densities above 500 asf are employed at 150° F. Hence, to produce "lustrous" copper plate at 150 to 200 asf, one must use bath No. 100–10 at temperatures of 90 to 120° F, depending upon the ductility desired‡.

The ductility mentioned above refers to the effect of bending of the test panel through 180°. If *all* plates in a series produced under identical conditions show absence of cracks on sharp bending, the coating is called highly ductile. The less ductile plates are not brittle, but have occasional fine hair-line cracks after sharp bending, i. e., some plates show hair-line cracks while others do not. If these less ductile plates are bent through a one-inch or larger radius, no cracks are visible.

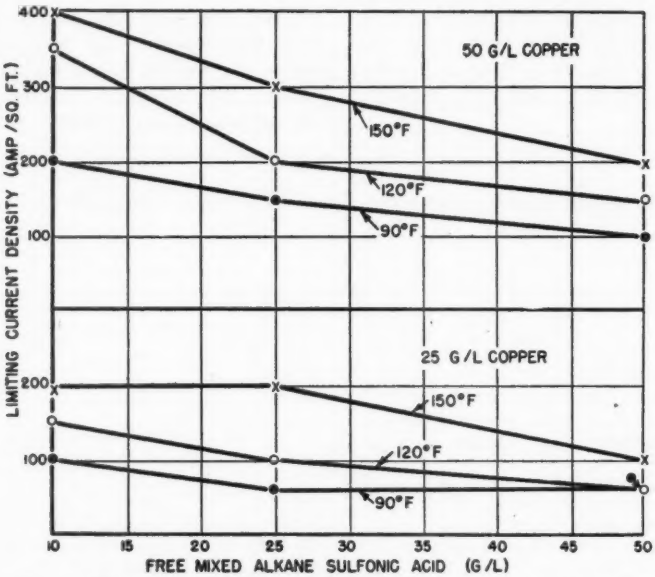


Fig. 1. Effect of free mixed alkanesulfonic acid on the limiting current density of copper alkanesulfonate baths containing 25 and 50 g/l copper

The "lustrous" plates are easily buffed, mechanically and electrolytically. No graininess is apparent after buffing. In addition, bright nickel plated directly upon a "lustrous" plate has a good color. This property is a distinct advantage for a simple acid copper bath, since a buffing step may be eliminated with significant cost saving.

‡Since the work reported here was completed, research was initiated on the improvement of ductility, per se, under a given condition of temperature, concentration and current density. The results to date are very promising and will be reported later.

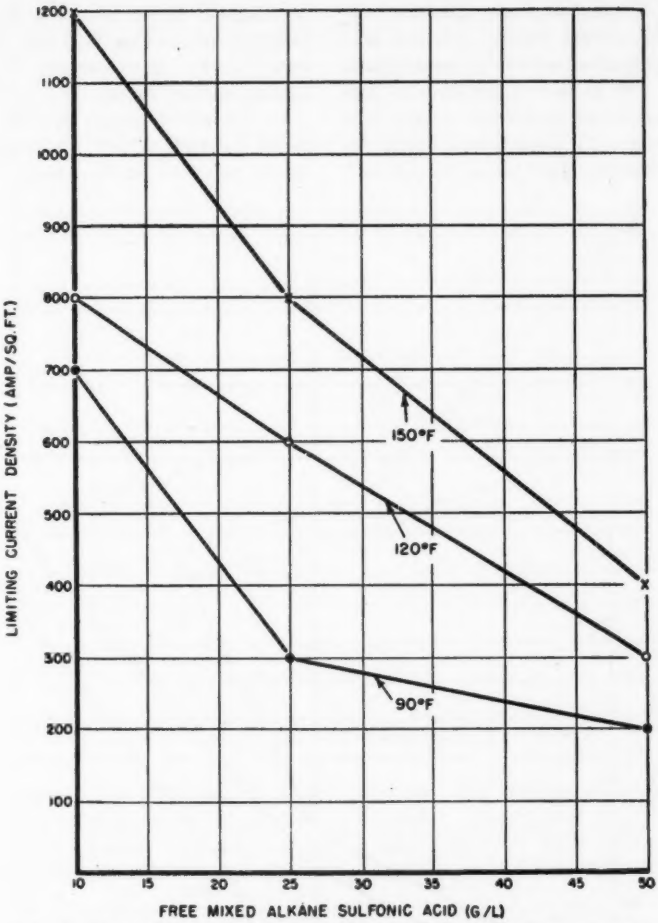


Fig. 2. Effect of free mixed alkanesulfonic acid on the limiting current density of a copper alkanesulfonate bath containing 100 g/l copper

Bath and Conditions for High-Speed Plating

The plates from bath No. 100–10 at current densities up to 800 asf are fine grained and may be matte or "lustrous," depending on the current density. The "lustrous" plate is obtained at the higher current densities.

This bath has not been extensively investigated for high-speed plating. Any further study will depend on whether special applications requiring it appear or not.

Effect of Plating Variables

EFFECT OF FREE ACID

The free acid content must be kept in the range of 5 to 10 g/l if good ductility and high limiting current density are to be maintained. An increase in the free acid content causes the limiting current density to decrease markedly, especially for bath No. 100–10 (Figs. 1 and 2). It also appears to cause a slight decrease in ductility. A decrease in the free acid content to below 5 g/l raises the limiting current density to as high as 1400 asf, but the plate has a tendency to peel and crack on bending. The free acid content is not critical in the range shown for baths No. 25–10 and No. 50–10, and the 10 g/l limit may be exceeded to some extent with no detrimental effects.

However, if the baths are operated near the limiting current density, the free acid must be maintained within the limits given. Bath No. 100–10 is very sensitive to free acid content insofar as limiting current density is concerned. Except for a slight decrease in ductility, good plates are obtained up to 50 g/l free acid. However, the limiting current density is reduced from 1200 to 400 asf. For that reason, the free acid in bath No. 100–10 must be maintained within the range of 5 to 10 g/l.

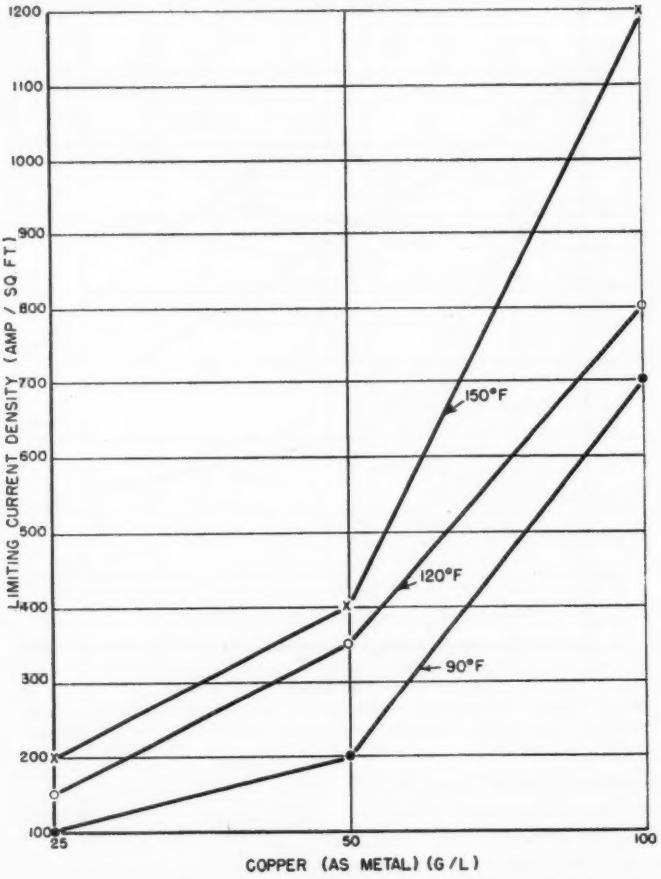


Fig. 3. Effect of copper concentration on limiting current density of a copper alkanesulfonate bath containing 10 g/l free acid

Effect of Copper Content

The only effect of the copper concentration appears to be related to the limiting current density (Figs. 3, 4 and 5). An increase in the copper content increases the limiting current density, and vice versa.

An increase in copper content results in plates that emit a "cry" on bending similar to that produced on distortion of block tin. The cause of this phenomenon has not been established, but it is probably related to the crystal structure. Baths containing 25 g/l copper produce only a few plates that "cry". When the copper content is increased to 100 g/l, a majority of the plates have that characteristic. (Refer to Fig. 6.)

This "cry" may be related to ductility,

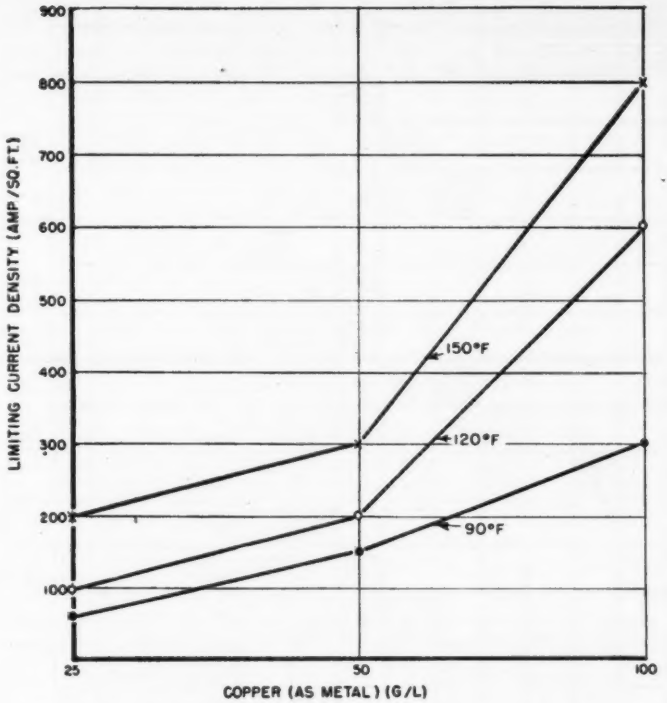


Fig. 4. Effect of copper concentration on limiting current density of a copper alkanesulfonate bath containing 25 g/l free acid

but the relation is not obvious. "Crying" plates, 0.001 inch thick, may be bent 180° without visible cracks. However, heavy plates, 0.010 inch or thicker, may crack on bending. The cracking of the plates is not consistent. Some plates that "cry" do not crack when bent, while others do. This inconsistency indicates that the "crying"

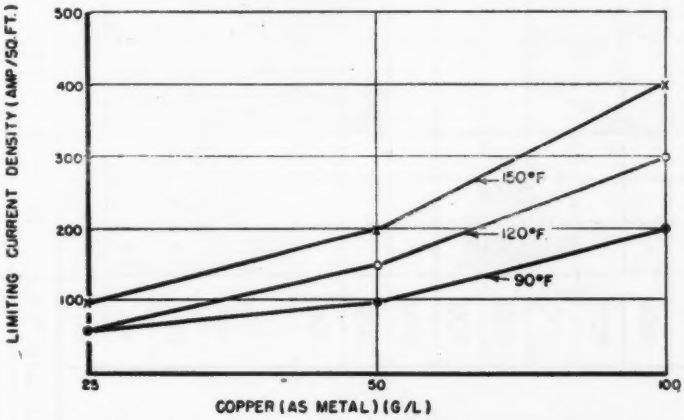
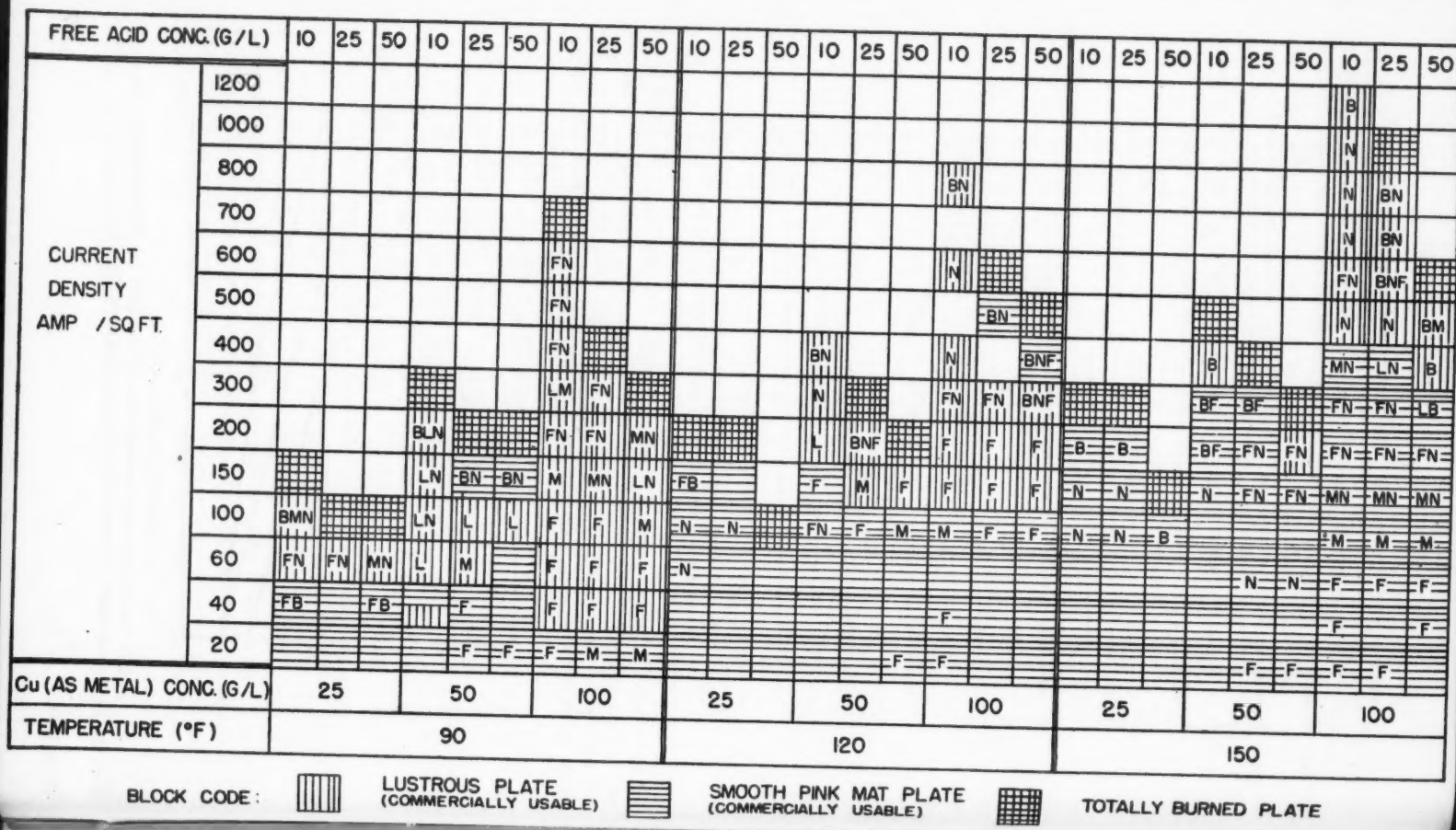


Fig. 5. Effect of copper concentration on limiting current density of a copper alkanesulfonate bath containing 50 g/l free acid


FREE ACID CONC. (G/L)
10 25 50 10 25 50 10 25 50 10 25 50 10 25 50 10 25 50 10 25 50 10 25 50 10 25 50
CURRENT DENSITY AMP /SQ FT.
1200
1000
800
700
600
500
400
300
200
150
100
60
40
20
Cu (AS METAL) CONC. (G/L)
25 50 100 25 50 100 25 50 100
TEMPERATURE (°F)
90 120 150
BLOCK CODE:
LUSTROUS PLATE (COMMERCIALLY USABLE)
SMOOTH PINK MAT PLATE (COMMERCIALLY USABLE)
TOTALLY BURNED PLATE

← **Fig. 6. Characteristics of copper coatings from alkanesulfonate baths deposited on flat panels, 1 x 3 inch. Letter code: B = burning on edges, N = nodules on edges, F = faint crying, M = moderate crying, L = loud crying**

phenomenon and ductility are not caused by the same series of circumstances.

Effect of Temperature

Temperatures of 120° to 150° F may be used. Below 120° F, the plates are less ductile and heavy plates are likely to crack on bending. A higher temperature increases the ductility and limiting current density. For that reason, a temperature of 150° F is recommended for the plating baths. The region above 150° F has been little investigated since plating takes place so well at the temperature shown herein.

Another effect of temperature relates to the "cry" emitted by the plates. Increasing the temperature minimized the "cry". At 90° F, a large number of the plates had either a loud or moderate "cry". At 150° F, however, the number of plates emitting "cry" was reduced, and these plates only emitted a faint or very faint sound. (See Fig. 6.)

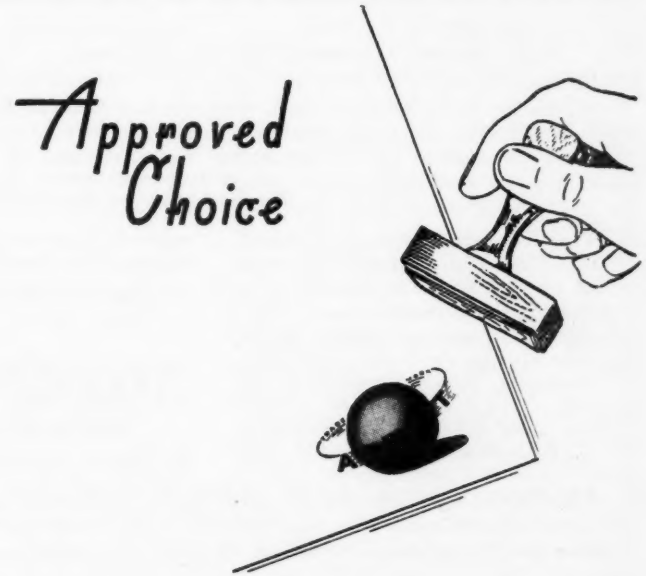
Effect of Current Density

Increasing the current density makes the plates finer grained, and, as the limiting current density is approached, they become "lustrous" or semi-bright. It appears to decrease the ductility slightly. However, plates made at or near the limiting current density can be bent 180° around a ⅛ inch radius without cracking.

The plates are fine grained, matte, smooth, and satiny at current densities just below the current densities producing the "lustrous" plates. (See Table II.)

(Continued in June Issue)

BLOCK CODE: LUSTROUS PLATE (COMMERCIALLY USABLE) SMOOTH PINK MAT PLATE (COMMERCIALLY USABLE) TOTALLY BURNED PLATE



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ATMOSPHERIC CORROSION of Iron and Steel

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CEDAR CREST COLLEGE, ALLENTOWN, PA.

INTRODUCTION

In many ways it is unfortunate that to fulfill the great demand of our present civilization for metal, we must depend principally upon iron. The problem of corrosion would not exist if, for example, platinum had happened to be the most plentiful metal. Actually aluminum occurs in the greatest amount in the earth's crust, but iron is the most cheaply obtained and we are forced to make the best of its faults, notably its susceptibility to corrosion. Many electroplaters would be in other occupations if it were not for the tendency of iron to rust. However, few metals are as versatile in their properties as iron. Heat treating, cold working and especially the addition of small amounts of other elements make great changes in hardness, tensile strength, ductility, etc.

The annual world losses due to corrosion of iron and steel are oft quoted figures of astronomical proportions. Yet[1a] the figures do not fully represent the annoyance caused by failure or breakdown of metal installations at crucial moments, nor the worry this possibility causes in the minds of those responsible. Maintainance of protective coatings is an expensive and monotonous chore.

The number of books on the technology of corrosion is very small, but the number of persons engaged in the prevention and control of corrosion is extremely large. Any addition to corrosion literature, however small, can be helpful to them. This article is an attempt to summarize present-day knowledge of atmospheric corrosion of iron and steel for the worker in metal finishing who wishes to understand more about his field of work.

Definitions

Before proceeding it will be best to make clear exactly what is meant by the terms iron, steel, tarnishing, corrosion, rust and passivity.

Iron is an element, one of 92, which constitute the material part of the world we know, including ourselves, the earth, the moon, the sun and the stars.

The term *steel* generally refers to iron containing between 0.08 and 1.5 per cent carbon and, in some cases, manganese, but in addition may refer to alloy steels. These consist of iron plus such elements as chromium, vanadium, nickel, silicon, copper and molybdenum. In this article the word will be used in its more narrow sense, i. e., to mean carbon steel.

Tarnishing[2a] cannot always be distinguished from corrosion, but is usually taken to mean uniform formation of an adherent coating which dulls the finish of the metal and may be somewhat protective.

Corrosion involves chemical attack of the metal surface and formation of a product which is not very protective and, in many cases, actually accelerates further attack. It has been called the return of a metal to a mineral[1b]. Corrosion, like erosion, results in removal of material, while tarnishing causes an increase in weight since the coating is adherent and contains an element

taken from the air. The distinction is somewhat arbitrary and, at times, it is difficult to classify a given case.

Rust is a term properly applied only to iron and is a corrosion product consisting of various oxides of iron plus more or less water. Its composition will be discussed in a later part of this article.

Passivity is a subject which has received much attention from research chemists; the explanation turns out to be quite simple, as will shortly be explained. Briefly, the phenomenon referred to is the abnormal stability of certain metal surfaces toward corrosion. Steel dipped into concentrated nitric acid is said to be passive. Untreated steel dipped into copper sulfate solution dissolves slightly, and an immersion coating of copper is deposited. Passive steel is unaffected. Stainless steel is the outstanding example of a passive ferrous alloy.

CORROSION BY MOIST AIR

Iron rusts much more rapidly in atmospheres of high humidity than low, especially where dew frequently condenses on the surface. Though the temperature at which moisture condenses on a polished surface, the dew point, is very definite, it is an interesting fact[1c] that condensation can take place in the crevices of a rough surface at temperatures well above the dew point, in other words at relative humidities less than 100 per cent. This is one reason why highly polished surfaces are more resistant to corrosion than rough surfaces. Another is that rough surfaces react much faster in a given chemical reaction than smooth ones. The explanation of this is that the atoms of metal extending beyond the others are not very strongly held to the body of the metal and are very reactive. Hence to avoid corrosion, smooth surfaces are preferable. It is of interest to learn[3] that a square of rolled sheet steel measuring one inch by one inch has an actual surface area, due to irregularities, of approximately two square inches. When roughened with sandpaper or polished with abrasive, the actual area becomes about six square inches, and when heavily etched with acid, this figure may go as high as one thousand square inches for the same surface measuring one inch by one inch. The rapid rusting of pickled steel is an example of large actual surface area reacting rapidly, though some of the effect is due to chloride ion if hydrochloric (muriatic) acid was used in the pickle.

An Experiment with Water Drops[1c]

Since water speeds up rusting, putting drops of water on a piece of iron or steel and observing the results after a period of time might be instructive. This sounds simple, yet what happens is not simple and devising explanations even less so. Suppose the steel is polished, with no signs of rust, and that a large number of water drops are placed upon it. After letting it stand for several hours in a moist atmosphere to prevent evaporation, the wetted areas are examined. There will be found three types of results. Under some water drops, no rusting occurs; under others, the rusting is uniform and adherent and usually very thin; under the third class, pitting and etching occur in the center and the edge is bright, with a ring of rust accumulating in between. The latter type may not be noticed since it may be complicated by shrinkage of the drop and a covering of loose rust, but wiping off the rust will disclose the etched center and the bright surrounding ring. The questions are: why do these three cases occur, and how does the corrosion take place.

The Invisible Film

Using the electron microscope, it has been definitely proved that a freshly polished metal surface quickly becomes covered with a film of oxide by reaction with oxygen of the air, so thin as to be invisible. Such a film protects stainless steel and is responsible for the phenomenon of passivity. Depending upon the method of polishing, the temperature, the type of metal, the time since polishing, etc., the film possesses different protectiveness and is not even uniform on one piece of metal. This explains why rusting occurs under some drops of water and not under others. If the oxide coating under the drop is sufficiently thick and has no cracks or thin spots, no rust forms.

Before going into the mechanism of the two types of corrosion under water drops, i. e., the uniform, adherent rust type and the bright-ringed, etched-center type, it will be necessary to go into the chemistry of the process.

The Chemistry of Corrosion

Corrosion of iron by a relatively clean, moist atmosphere is essentially a reaction with oxygen to form iron oxide. However, it is complicated by the fact that iron can form two oxides, ferrous or FeO, and ferric or Fe_2O_3, the second requiring more oxygen than the first. The oxides formed by atmospheric corrosion contain water and have the formulas $FeO \cdot H_2O$ (also written $Fe(OH)_2$) and $Fe_2O_3 \cdot H_2O$ (more correctly written $FeO(OH)$[1d], really not very different since $2FeO(OH) = Fe_2O_2(OH)_2 = Fe_2O_3.H_2O$). They do not form directly, but by the following mechanism: First some ferrous iron atoms go into solution as Fe^{++}. We can call the part of the metal surface where this happens the anode. Since the atoms originally had no net electrical charge, this means that each has left two negative charges or electrons on the metal:

$$Fe = Fe^{++} + 2\,e^- \quad (1)$$

These electrons are free to move along the metal surface (they form the electric current in a wire or bus bar) and are taken up by hydrogen ions (H^+)* from the water as follows:

$$e^- + H^+ = H \text{ (an atom of hydrogen with no charge)} \quad (2)$$

This region of the surface is the cathode since hydrogen is deposited. The hydrogen ion came from the dissociation of water:

$$H_2O = H^+ + OH^- \quad (3)$$

If the net reaction of (2) and (3) is obtained by adding the left-hand sides and the right-hand sides and cancelling H^+ which then appears on both sides, we can see that the number of OH^- has increased, which means that the water in that neighborhood has become alkaline:

$$H_2O + e^- = H + OH^- \quad (4)$$

The hydrogen atoms cling to the surface of the metal and prevent more iron dissolving until they are removed in some way. The quantity of hydrogen is too small to be given off as gas bubbles. It is removed by atmospheric oxygen (O_2) that has dissolved in the water, the reaction being:

$$O_2 + 4H = 2H_2O \quad (5)$$

The hydrogen, which originally came from a water molecule, returns to it and the net reaction becomes:

$$2Fe + O_2 + 2H_2O = 2Fe^{++} + 4OH^- \quad (6)$$

This mechanism is made more complicated by the change of ferrous ion (Fe^{++}) to ferric ion (Fe^{+++}). This occurs by direct reaction with more oxygen in the water:

$$4Fe^{++} + O_2 + 2H_2O = 4Fe^{+++} + 4OH^- \quad (7)$$

The familiar brown rust is then produced:

$$Fe^{+++} + 3OH^- = FeO(OH) + H_2O \quad (8)$$

This form of rust, which may be either of the minerals goethite or lepidocrocite[5], loses water on aging to form Fe_2O_3.

If reaction (7) is not very rapid, due to the slow arrival of oxygen, a mixed ferrous-ferric product forms:

$$Fe^{++} + 2Fe^{+++} + 8OH^- = FeO \cdot Fe_2O_3 \cdot H_2O + 3H_2O \quad (9)$$

This green product, also written $Fe_3O_4 \cdot H_2O$, if aged in the absence of oxygen, loses water to become the common black mineral, magnetite (Fe_3O_4).

Now[1e] it is possible to understand why thick layers of rust are sometimes brown (Fe_2O_3) on the outside, green $(Fe_3O_4 \cdot H_2O)$ or black (Fe_3O_4) in the middle and white $(FeO \cdot H_2O)$ next to the metal surface.

*It is now known that the hydrogen ion is attached to a water molecule and therefore should be written H_3O^+, but to simplify the equations H^+ will be used in this article.

Final Explanation of the Water Drop Experiment

To return to the rusting of iron under drops of water, the two types of corrosion are due to the presence of in one case a partially protecting film and in the other, little or no protecting film.

Where the film partially protects the surface, iron atoms go into solution slowly and their concentration is low. Oxygen from the air is in high concentration and rapidly oxidizes and precipitates the iron ions before they travel very far from the iron surface, thus forming an adherent coating which hinders further corrosion.

In water drops where considerable rust has formed between an etched center and an unattacked outer ring, there is evidently little protection by an oxide film. The corrosion is thought to proceed as follows: first iron goes into solution rapidly all over the metal surface under the drop (reaction 1). Hydrogen is formed on the surface (reaction 2) and is removed by oxygen (reaction 5). Now consider the path by which this oxygen must reach the metal. It goes from the air into the water and then to the metal. Along the edge of the drop where the water layer is thin the oxygen reaches the metal quickly and precipitates the iron ions before they can travel far, thus forming a protective coating. However, the coating is thin and electrons can pass through it. In the center of the drop the water layer is thick and oxygen arrives more slowly. Before long the hydrogen on the surface and the ferrous ions leaving it use up all the oxygen (reactions 5 and 7) in the neighborhood of the surface, and the ferrous ions must travel some distance outward and upward before encountering more oxygen. Since hydrogen is no longer removed by oxygen in the center but is removed on the edges where oxygen is plentiful, the electrons formed by reaction (1) travel along the metal surface to the edge where they can react with hydrogen ions. The edge of the water drop becomes alkaline (reaction 4), and the hydroxyl ions travel inward, encounter ferric ions moving outward and precipitate a ring of ferric hydroxide (reaction 8) between the etched center and the bright edge.

This theory satisfactorily accounts for the results of the experiment which, as previously mentioned, started out very simply but ended up with a rather complex explanation. Incidentally, the center of the drop is the anode since metal dissolves there, and the bright ring is the cathode since hydrogen is deposited there.

Differential Aeration

The water drop experiment has led to other studies of the corrosion of two connected metal areas in contact with water where the oxygen concentration is higher over one area than over the other (e. g., the edge of the drop and the middle of the drop). This *differential aeration*[2b] results in the corrosion being most rapid on the part of the surface over which the oxygen concentration is the lowest. Stated more broadly, *corrosion by air and moisture is most serious in the regions where air has the least access.* This is one of the causes of pitting, the most insidious form of corrosion. It proceeds in the remote parts of a structure and may not be detected until serious damage has been done.

It is a significant fact that, under similar conditions, two similar pieces of metal corrode at the same rate (measured by loss in weight of the pieces) even though the corrosion of one may be of the pitting type while on the other it takes place uniformly. The total corrosion is determined by the supply of oxygen and not by surface conditions.

CORROSION BY ATMOSPHERIC IMPURITIES

Certain impurities in the atmosphere cause corrosion that is much more rapid than corrosion by pure air and moisture[2c]. The principal offenders are sulfur dioxide from the burning of coal and coal gas containing sulfur, hydrogen sulfide from the same sources, and sodium chloride from ocean spray carried many miles inland in the form of tiny drops by on-shore winds. It is generally agreed that the damage previously attributed to carbon dioxide in industrial districts was in reality due to sulfur dioxide.

An experiment of R. B. Mears[6] showed that when a large number of drops of water were placed on a piece of steel, rusting occurred under 5 per cent of them, and that the addition of 1 per cent sulfur dioxide to the atmosphere caused corrosion to take place under all the drops. The velocity of corrosion in the second instance was 26 times greater, comparing only the drops under which the steel corroded in both cases.

In contrast to the above experiment with sulfur dioxide, it was found[7,8] that carbon dioxide increases the velocity of corrosion under water drops which already show corrosion, but the percentage of drops affected is not changed at all. In the absence of visible drops, the presence of carbon dioxide actually reduces the rate of rusting[9]. Evidently the rust is made more protective by the carbon dioxide.

There are two reasons why sulfur dioxide causes an increase in corrosion of iron and steel. First, and this also applies to the effect of carbon dioxide on wet steel, the impurity is an acid, and the increase in acidity of wet areas speeds up the solution of iron (reactions 1 and 2) provided that oxygen arrives fast enough to remove the hydrogen as fast as it is formed. Of course, if the water is sufficiently acid, bubbles of hydrogen may be released and corrosion becomes rapid indeed. It has been noted that rain in heavily populated sections is more acid in winter than in summer due to change in coal consumption with the season[1f].

The second reason for the effect of sulfur dioxide lies in the nature of the corrosion product formed. It has a stronger attraction for water than does ferric oxide and, as has already been shown, wet steel corrodes faster than dry. Some of the products are even hygroscopic, that is, they abstract moisture from the air in such quantity that they themselves dissolve. Carbon dioxide forms a product with very little attraction for water and therefore its effect is slight.

In this connection, the *principle of critical humidity*, developed by Vernon[10,11], Hudson[12] and others, may be mentioned. These investigators found that, dependent upon the corrosion product, there is a certain percentage relative humidity above which corrosion is rapid and below which it is slow. This critical humidity is the minimum relative humidity necessary to wet the corrosion product and is, therefore, a measure of its attraction for water.

Increased corrosion by sodium chloride from sea winds is due to the chloride part of the compound, not the sodium. Its effect is analogous to that of chloride ion in a nickel plating bath where it improves corrosion of the anode. The fundamental cause of the corrosive effect of chloride ion is not very well understood. Some investigators attribute it to the dispersing effect it has upon the corrosion product, causing it to form a colloid. Chloride ion can form complex ions with iron and this may have a bearing on its corrosive powers. Another certain factor is the hygroscopic nature of ferric chloride and of sea salt itself. Pure sodium chloride is not hygroscopic, but magnesium chloride is and sea salt contains a small amount of it. Table salt gets damp in wet weather for the same reason.

Putting all these observations and theories together, it is easily understood why corrosion is more rapid in industrial regions than in rural, in humid atmospheres than in dry, and near the coast than inland.

PROTECTION OF IRON AND STEEL

A brief outline of the methods used to protect iron and steel from corrosion is a logical part of an article on corrosion. The methods used can be classified as follows[1a]:

1. Composition change
2. Natural protective coatings
3. Artificial protective coatings
   (a) Non-metallic
   (b) Metallic

Composition change.—The addition of large amounts of nickel or chromium and nickel (stainless steel) gives good resistance to corrosion due to formation of a thin protective oxide film. Naturally the cost of the product is materially increased. Smaller amounts of chromium[1g] (around 1 per cent) have given a product with double the life of ordinary steel. The addition of very small

amounts of two other elements have a marked effect on the corrosion rate of steel. Sulfur speeds up corrosion and should be kept as low as possible. Copper[1b] greatly reduces the rate of corrosion of steel when present to the extent of only 0.15 per cent and is commonly added for this purpose. For some reason, its addition to Bessemer steel gives a more durable product than when it is added to wrought or pure iron. Since such a small amount of copper is required, the increase in cost is not great.

Natural protective coatings.—These coatings are formed simply by exposure of the metal to the atmosphere. With the exception of stainless steel they are of less importance to ferrous metals than to non-ferrous. They do have some effect, however. Freshly polished steel corrodes more rapidly when when placed out-of-doors at once than when it has been first aged indoors for some time after polishing. The copper-bearing steel just mentioned forms a hard adherent natural coating which is at least partially responsible for its resistance to corrosion. Generally, however, the natural coatings formed on ordinary steel accelerate, rather than retard, corrosion. The reasons for this have already been discussed, namely, their absorption of moisture and their effect in causing differential aeration of the surface.

Artificial protective coatings.—Lastly we come to the field of the metal finisher, artificially produced coatings. These include black oxide and phosphate coatings; metal coatings produced by electroplating, hot dip and hot spray methods; vitreous enamels and organic coatings such as paints and lacquers. Their mode of action and relative merits are outside the scope of this article and is a huge topic in itself.

CONCLUSION

It is hoped that atmospheric corrosion of iron and steel is now more intelligible to the reader. The process is not mysterious nor unpredictable, but is governed by definite physical and chemical laws. Since the laws involved are the same as those governing electroplating, the subject should not be very difficult for a plater to follow.

Those who desire to go further into the subject of corrosion, both of steel and of other metals, by fresh and salt water as well as by the atmosphere, should study Evans' book, *Metallic Corrosion, Passivity and Protection*, of which a new edition has just been published. (See Dr. Read's review in the March issue of this journal.) It is a survey of research papers by over 2,600 authors and is the most comprehensive and readable publication on corrosion to date.

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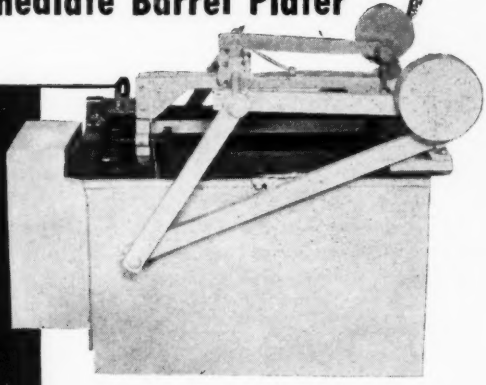

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JOB PLATERS ORGANIZE

The National Association of Metal Finishers, Inc., was recently incorporated under the Laws of the State of Michigan, with offices located at 2236–39 Dime Building, Detroit, Mich.

For several years, members of the metal finishing industry were cooperating with one another in meeting wartime situations and since the war, several meetings were held in Detroit, Chicago, and New York. At the Annual Dinner of the industry, which was held in Pittsburgh on June 18, 1946, an Organization Committee was appointed to prepare By-Laws and form a National Association of Metal Finishers. This Committee met on several occasions and prepared By-Laws, after which directors were elected preparatory to incorporating an association. On December 4, 1946, the Directors held their meeting at the Park Central Hotel, New York City, and elected officers as follows:

President, *Ed. J. Musick*, Musick Plating Company, 206 S. 9th Street, St. Louis 2, Mo.; First Vice-President, *R. A. Campisi*, Industrial Enameling Corporation, 81 Hano Street, Boston 34, Mass.; Second Vice-President, *C. R. Crawford*, Chrome-Rite Company, 4534 W. North Avenue, Chicago, Ill.; Third Vice-President, *Harold E. Coombes*, 165 S. Fair Oaks Avenue, Pasadena 3, Calif.; Treasurer, *Henry Bock*, Auto City Plating Company, 3456 Denton, Detroit 11, Michigan.

During the year of 1946 matters of importance were accomplished by the Organization Committee which actually functioned prior to the incorporation of the association, and a year-end bulletin, consisting of fifty-three pages was just sent to all members. In addition to the year-end bulletin, monthly bulletins were issued and will be issued by the association as a part of its activities. By-Laws were adopted by the Board of Directors as recommended by the Organization Committee. There is one class of membership in the National Association being that of a local association consisting of five or more members of the industry; each local association having a voice in the functions of the National Association by virtue of its membership.

Raymond M. Shock, the Executive Secretary, is now meeting with local groups of metal finishers throughout the country, helping them to organize into local associations, and it is hoped that during the year of 1947 most all metal finishers throughout the country will have an interest in this organization.

Any local group of metal finishers desiring further information and a copy of the By-Laws or bulletins will receive the same upon writing to the office of the Secretary, 2236–39 Dime Building, Detroit 26, Mich.

The first Annual Meeting of the association is scheduled to be held in Detroit on June 22 to 25 in the Hotel Statler.

Nace Establishes Award

The National Association of Corrosion Engineers has established two annual awards to be made in recognition of outstanding contributions in science and engineering as pertains to the field of corrosion. These awards, to be known as the *Willis Rodney Whitney Award in Science of Corrosion*, and the *Frank Newman Speller Award in Corrosion Engineering*, were presented for the first time during the Annual NACE Corrosion Conference at the Palmer House in Chicago April 7–10, 1947.

Appropriately, the first recipients of these newly established awards were the men whose names they will commemorate and perpetuate. Dr. Whitney is signally honored for his fundamental work in the field of corrosion through his establishment of the electrochemical theory in corrosion, while Dr. Speller receives just and due honor for his application of fundamental studies to practical engineering problems.

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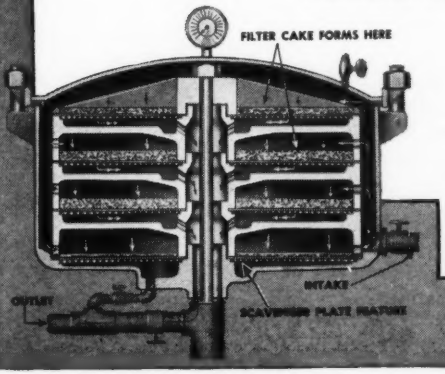

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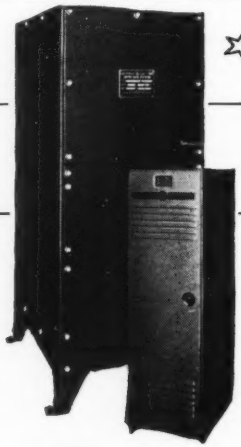

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A. S. T. M. COMMITTEE B-8 MEETS

New officers were elected by Committee B-8 on Electrodeposited Metallic Coatings at the meeting on February 28 during A. S. T. M. Committee Week in Philadelphia. C. H. Sample, who had been the Secretary, was elected to fill the unexpired term of R. J. McKay who resigned as Chairman, while R. B. Saltonstall will be Secretary. K. G. Soderberg remains Vice-Chairman of the Committee. New officers of most of the subcommittees were selected so that the present subcommittees and their officers are:

Sub. I. Specifications, Papers and Definitions, J. E. Stareck, Chairman

Sub. II. Performance Tests, H. A. Pray, Chairman; F. R. Keller, Secretary

Sub. III. Conformance Tests, W. A. Wesley, Chairman
Sect. 1. Thickness, A. H. Du Rose, Chairman
Sect. 2. Porosity, A. Mendizza, Chairman
Sect. 3. Adhesion, Hardness and and Ductility, E. J. Roehl, Chairman

Sub. IV. Electroplating Practice, F. K. Savage, Chairman; M. B. Diggin, Vice-Chairman, and K. M. Huston, Secretary

Sub. V. Supplementary Protective Finishes for Metallic Coatings, Marc Darrin, Chairman

Subcommittee I reviewed its work on definitions and reviewed papers by K. G. Soderberg, W. A. Wesley and H. A. Pray on methods of rating different types of exposure test panels. These papers are to be presented at a Symposium on the subject sponored by Committee B-8 at the A. S. T. M. Atlantic City meeting in June. Sub-committee II reviewed its program of exposure tests of lead and copper-nickel-chromium coatings on steel and reported on the results to date. Subcommittee III organized the three new sections noted above. These sections will work in close cooperation with Project Subcommittees on the same subjects of the American Electroplaters' Society Research Committee.

Subcommittee IV reported that it had substantially completed a recommended practice for preparation of high-carbon steel for plating (to be submitted to letter ballot action prior to the next meeting) and also reported plans for a similar recommended practice for preparing zinc-base die castings for plating. Subcommittee V reported that it was formulating plans to evaluate the protective value of supplementary protective treatments of electrodeposited coatings and planned to submit a proposed program at the next meeting.

Ben Popper Gone To His Reward

It is with deep regret that, as we go to press, we learn of Benjamin Popper's death.

"Ben", as he was affectionately known by his many friends, started his career with the Egyptian Lacquer Manufacturing Company on July 5, 1901 as an office boy with duties ranging from taking care of fires in the morning to sweeping up at night. In 1904, his ambitions to become a salesman were realized, and he was given a territory in New York City where he has worked continuously ever since. Ben was one of the first lacquer salesmen to be elected to the A. E. S. and his membership dates back over 30 years. He has served the Society long and well; Ben was one of the first to arrive at New York Branch meetings, greeting the newcomers with a smile and and offering helpful advice.

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(*Continued from page 539*)

all visitors wishing to avail themselves of the opportunity to examine the most complete library pertaining to the art of plating. This library is sponsored and equipped by the Detroit Branch of the A. E. S.

On the pleasure side, a full program of entertainment for the members and their wives has been arranged. Included in the plans are the Annual Good Fellowship luncheon and open house gathering in the evening of the opening day. Luncheons for the ladies, including fashion shows, have been arranged. One afternoon and evening will be given over to a general outing for the members, wives and friends, with luncheon aboard a boat, a cooling trip down the river into the lake, and dinner at famous Bob-Lo Island; dancing on the boat and island, golf on the island, and the Oneida Quartet singing ballads you love to hear.

The Plating Institute and the Job and Contract Platers of Detroit will be host to luncheons and also conduct their Annual Luncheon and Dinner.

Method of making hotel reservations was outlined on page 273 of the March issue

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KOHLER COMPANY WINS PATENT SUIT

The U. S. Circuit Court of Appeals for the Seventh Circuit has now handed down its decision in the case of United Chromium, Incorporated, vs. Kohler Company.

The Court reversed the decision of the District Court for the Eastern District of Wisconsin when it held U. S. Patent 1,581,188, April 20, 1926, to Colin G. Fink invalid in view of prior invention by Marvin Udy. It upheld the lower court's decision that U. S. Patent 1,802,463, April 28, 1931, also to Colin G. Fink, is invalid for lack of invention.

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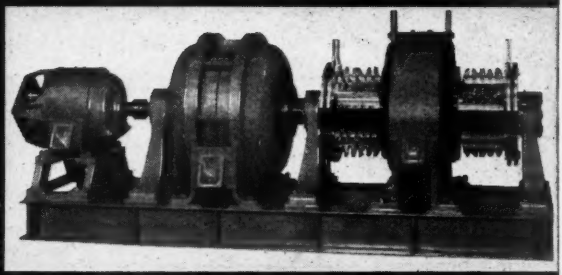

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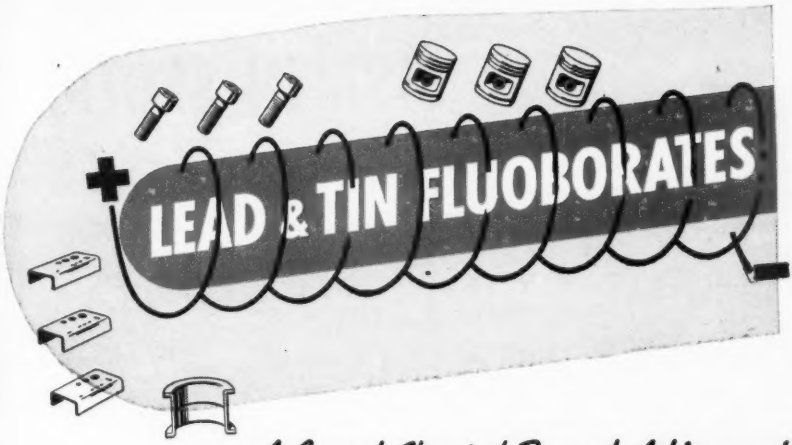

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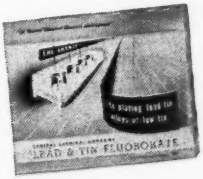

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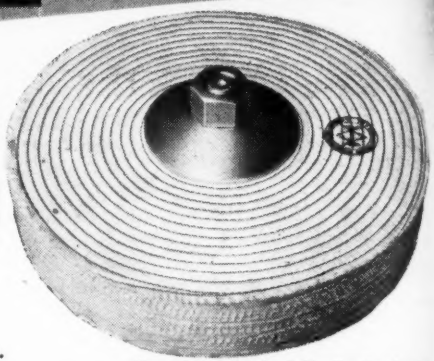

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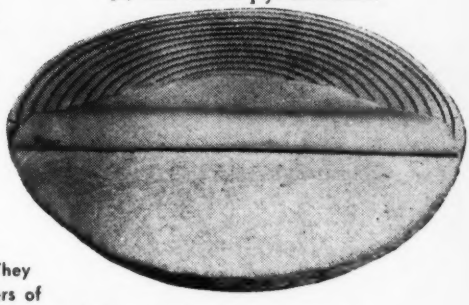

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POROSITY of ELECTRODEPOSITED METALS

A. E. S. Research Project No. 6

II. Critical Literature Review

N. THON
Project Director

E. T. ADDISON, JR.
Associate

Frick Chemical Laboratory, Princeton University, Princeton, N. J.

• ● •

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1. INTRODUCTION

[1.1] It is currently accepted that thin electrolytic metal deposits having thicknesses of the order of those used in protective and decorative electroplating (galvanostegic) practice are porous. The pores which connect the outer surface of the deposit with the base metal are commonly made responsible for the inadequate protection afforded to the base metal against corrosive attack by such agents as are presumed not to attack the protective deposit. It is obvious that a perfectly continuous layer of a nobler metal on a less noble base, for example nickel on iron, tin on iron, or gold on copper, would confer on the base metal unlimited ideal resistance to all attack to which the deposited metal itself is chemically

resistant. From this point of view, porosity of electrodeposited metals has a direct and decisive bearing on the vast problem of protection against corrosion.

[1.2] Knowledge of the extent, nature and causes of the porosity is, consequently, of paramount importance. It can only be gained from many-sided experimental observations which at the same time serve to demonstrate the very existence of porosity in electrodeposits. As will be shown in the following analysis, these experimental demonstrations are generally not of so compelling and unobjectionable a nature as not to be open to serious criticism. In some quarters, this has actually led to legitimate doubt or even rejection of the so widely accepted conviction of inherent porosity of electrolytic metal deposits and its gradual obliteration with increasing thickness. The experimental material underlying this conclusion can be shown to be capable of more than one interpretation and even dispense with the assumption of any original porosity in electrodeposits. Porosity will, therefore, not be taken for granted and its proofs of existence will have to be examined closely. Right at the outset, it should be pointed out that, in the writer's view, porous or discontinuous structure of electrodeposits is intrinsic. This will be shown to appear from the earliest research [2.1] and will be further developed in [5] on Causes and Nature of Porosity. In the course of this report it will become abundantly clear that testing methods draw a response only from certain types of pores; in particular it will be found that, in the main, only that type of porosity will be considered which permits ready penetration of chemical and physical agents from the outer surface to the base metal. It is with this type that the existing literature is almost solely concerned. It is well to bear in mind what will again be stressed in the final discussion, namely, that this particular porosity appears to be but a sub-type of the intrinsic porosity of electrodeposits.

[1.3] An outline of the early history of the problem will be followed by a classification, description and analysis of the methods of demonstration and of evaluation of the porosity and by a critical survey of the results and conclusions reached. On this basis, an attempt will be made to determine what causes the porous—or quasi-porous—behavior of electrodeposits and what conclusions can be drawn as to the nature of the structural elements which determine that behavior.

[1.4] This review, a preliminary part of the A. E. S. Research Project No. 6 and preparatory to experimental laboratory work, is based on a study of the available published literature supplemented by many valuable private communications of unpublished information, the courtesy of which is herewith gratefully acknowledged. A bibliographical list of references has appeared in the April 1947 issue of THE MONTHLY REVIEW. It will be found that only part of the sources listed in the Bibliography have been quoted and discussed in this report. This is due to the fact that many references which had to be included for the sake of completeness only report or apply previously published work or, while dealing with porosity of electrodeposits, do not add significantly to our fundamental knowledge of the problem.

[1.5] Experimental work on Research Project No. 6 has been going on for some time, partly overlapping the literature study which has led to this report. While the results of this work are still fragmentary and, when completed, will form the subject of subsequent publications in THE MONTHLY REVIEW, some preliminary findings wil.

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have to be mentioned here; they shall be referred to under (218) of the Bibliography. References (219) to (226) refer to unpublished private communications received by the Project Director.

[1.6] In this report, references to the Bibliography will be made only by the numbers of the corresponding entries placed in parentheses. Numbers in brackets, with a decimal point, supply cross-references to paragraphs of this report.

2. HISTORICAL

[2.1] As early as 1887, the question was raised as to how thick a layer of a metal it is necessary to deposit on a nobler metal, specifically platinum, in order to impart to it the electromotive properties, i. e., the electromotive potential, of the deposit (1). From the minimum weight of the deposit at which the electrode acquires the new electromotive behavior, minimum thicknesses were computed: 2–3 millimicrons for zinc, 1–2 for cadmium, 1 for copper. There is no reason why layers from 10 to 30 atoms deep should be necessary in order that the electrode act as the new metal. Such high figures can only be understood if it is concluded that electrodeposition, far from being uniform and continuous, actually takes place spotwise; in other words, that, on some parts of the cathode, metal is deposited from the very beginning and grows in thickness while other areas remain bare at least for some time during the early stages of the deposition. Hence, the minimum thicknesses given by (1) have little meaning, except that the figures strongly indicate the discontinuous nature of electrodeposition and the porous structure of at least the earliest layers of the deposit. The presumption that this may continue on further growth is not unjustified. Inasmuch as platinum is easily cleaned and freed from surface impurities, it can be considered to approximate very closely an ideal metallic base; hence, gross base metal imperfections cannot play the decisive role as the cause of the porosity of the deposit which, as will be seen later, is being frequently ascribed to that factor. Discontinuous structure of the deposit in this early research appears to be inherent in the very mechanism of growth of electrodeposits.

[2.2] On the practical side, concern over the porous nature of protective metal layers as a probable cause of unsatisfactory resistance to corrosion in service seems to have first arisen in connection with the tinning of iron by dipping in hot molten tin (4). Such tinplate was observed to exhibit tiny round holes reaching down to the base iron and termed pinholes owing to their visual appearance. Pinholes are obviously nothing but particularly large pores visible to the unaided eye without auxiliary revealing agents. As it could be surmised that many more pores are present in the tinplate and might be made observable with the aid of suitable chemical developers, a reagent was applied, the main ingredient of which, potassium ferricyanide, was first used two years earlier (3) to test local corrosion phenomena on massive iron and steel. In this first application, tap water with a trace of ferricyanide and a few drops of phenolphthalein was used on the iron surface; local cathodic behavior was indicated by red coloration, anodic attack by a blue precipitate of ferro-ferricyanide. The name "ferroxyl" which has since been in common use for various ferricyanide-base porosity reagents is said to have been suggested by A. S. Cushman (3). In the same publication, addition of neutral gelatin or agar as thickening agent was recommended for the first time. In Walker's (4) investigation of pinholes in hot-dip tinplate, the ferroxyl reagent was made up of 1 g potassium ferricyanide, 1 g sulfuric acid, 50 g gelatin and 450 g water; the "majority" of pinholes were said to have developed after 30 minutes. Right here it should be pointed out, what will apply to all subsequently developed test methods of a similar type including the most modern and perfected ones, that there is no hint or shadow of a proof that the number of spots formed in the 30 minutes reproduce the majority or any other known fraction of the pores present in the plate. This early porosity test did not concern itself, either, with the possibility that the reagent might corrode tin and by attacking it at certain points pro-

duce pores where there were none initially. This twofold uncertainty will be shown to attach to a major part of subsequent modern work.

[2.3] With regard to electrodeposits, early mention is made of their probably porous nature in connection with sundry observations such as, for example, of the anodic removal of nickel deposits from iron (2). The first significant attempts at direct demonstration were made (7) with agar-thickened Walker's reagent [2.2] on noble-metal deposits on iron. With increasing thickness of the deposit, the density of the spots was found and without exception is still being found to decrease. On such evidence, porosity of nickel and of copper deposits on iron was—and is still fairly unanimously—recognized to decrease with increasing thickness and to disappear at deposit thicknesses of the order of 0.001 inch (0.0025 mm). This reasoning and result are the prototype of most of the subsequent work on porosity. At an early stage, too, salt spray, a corrosion testing procedure apparently also first used on hot-dip plate (zinc), was made to serve as and was considered a means of testing not only the resistance to corrosion but also the porosity of the deposit (14, 17, 19), and a correlation was established between the ferroxyl and the salt spray test results. Soon new porosity testing methods were added, first in importance being the hot water test (68) also first applied to hot-dip plate (tin). On these foundations, other new procedures were developed, permitting an increasing number of comparisons and criticism of results. The methods will be classified, described and discussed in the following section.

3. METHODS OF DEMONSTRATION AND EVALUATION OF POROSITY

3A. Classification of Methods

[3A.1] Any procedure of demonstration, provided it truly reflects the original porosity of the deposit, must at the same time constitute a method of quantitative evaluation. Results may still be divergent due to insufficient reproduction of all the factors which determine the quality of a deposit because deposits produced under seemingly identical conditions may differ owing to unknown variation of one factor or another. The method itself, however, must reliably indicate the actual degree of porosity of the given sample.

[3A.2] Methods thus far proposed fall into two main categories. In one class, [3B], chemical agents are applied to mark each individual pore, and the total porosity of the deposit is expressed by the result of a count of pores per unit area. Such tests must meet several requirements: (a) They must be non-destructive for the deposited metal, i. e., it must be demonstrated that the reagent itself does not attack the deposit, not even at certain privileged spots such as areas of thinner-than-average plate or of higher-than-average electromotive potential due to stress, crystal orientation, etc.; this latter condition being too stringent to be sufficiently approximated, it must be required at least that the rate and mode of attack by the reagent be well known and that it be proved negligible, both with regard to amount and to predilection, within time intervals distinctly longer than those during which the test reagent is applied. (b) The fraction of the actual number of pores and the type of pores revealed by the given reagent must be known. (c) The relation between the revealed pore pattern and the time of exposure, and the effect and meaning of the end-point of the test in terms of actual porosity must be established. (d) The count must be reasonably independent of personal visual acuity of the observer, of illumination and of magnification. Right here it should be pointed out that requirement (c) can hardly ever be expected to be fulfilled even approximately; the end-point is simply imposed by the growing extrusion of reaction products and their blurring and spreading over neighboring marks; exposure *must* be arbitrarily curtailed, and the end-point stands in no relation to any full or stationary development of the pore pattern. Methods of this class, [3B], mostly involve reactions with the base metal; in a particular case, the deposited metal is permitted to be involved in the test reaction [$3B_4$]. Another sub-

type, [3B$_7$], of this class not yet extensively developed or used, is supposed to involve no reaction with either the base or the deposit. Methods of the [3B] class, even in the ideal case of fulfillment of all the above conditions, can supply no information regarding the size of the pores or the porosity of the deposit in terms of cross-section of volume.

[3A.3] Methods of the second class, [3C], comprising tests by chemical reactions and by physical procedures such as permeability or diffusion through the pores, can supply an indication of the degree of total porosity of the sample but are unable to give either the number of individual pores or their distribution pattern. Nonetheless, if some such method can be shown to reflect and to express on a logical numerical scale the authentic degree of original porosity of a deposit, it will constitute a priceless basis for the central problem: the relation between porosity and corrodibility. Physical methods of this class are only beginning to be developed and deserve fullest attention.

[3A.4] The obvious physical testing procedure of separating the deposit from its base and inspecting it for pores in transmitted light might have been included in the [3B] class inasmuch as it would appear to furnish an image of each individual pore together with a rough estimate of its size. In some cases, easily detachable deposits can be produced on special bases, for example nickel on stainless steel. However, proof is required that no pores are produced in the separation of the film from its base. Furthermore, it cannot but be conceded that such intentionally non-adherent deposits are in no way comparable to the adherent deposits which are of practical interest. The same applies to deposits produced on surfaces so treated—chemically or mechanically—as to impair adherence. In other cases, separation can be brought about by dissolving the base metal with a reagent harmless to the deposit; thus, nickel was separated from zinc by dissolving the latter in weak hydrochloric acid (98) and from copper or brass by a chromic-sulfuric acid mixture (221). The method is obviously most safely applicable to precious metal deposits; proof of absence of *all* damage to the material of the deposit is paramount but exceedingly difficult to furnish*. The simplest way of examination is to hold the deposit against light; photography by contact on photographic paper has also been reported (221) but requires precautions to avoid spots from dust particles (224). Most accurate results are obtained by inspection in transmitted light under the microscope (218). Here pores appear as bright points on a black background and can be easily counted and classified by size; mechanical tears are also easily distinguishable from pores. The reason why this method of inspection has not been classified under [3B] lies in the following consideration: in transmitted light only *straight* pores very nearly vertical to the surface can be expected to be seen; with pores reaching to the base along a broken or a winding path distinctly oblique to the surface, the film will be opaque. While such pores consequently will go undetected in light transmittance tests, they should be detectable by the [3B] methods because non-linear shape or oblique position do not in the least prevent penetration of the reagent or protrusion of the colored products although the required time may be longer than with short, straight and perpendicular pores. Inspection in transmitted light consequently detects only one particular type of pores and is, therefore, of limited application and significance. That pores of the other type do exist and respond to unobjectionable [3B] methods has been demonstrated (218), a point which, with its importance, will be

*This requirement is worth stressing, particularly on account of the suggested possibility—to be more fully discussed at a later stage—of non-metallic (oxidic or basic salt) inclusions in the deposit forming "potential" pores which of course would immediately become actual pores if dissolved by acid. Inasmuch as such inclusions and the idea of the "potential" pores are by no means to be dismissed lightly, separation by solution of the base is of dubious permissibility, even if the solvent is harmless to the *metal* of the deposit.

reemphasized and discussed later. Transmitted light inspection, preferably under the microscope, is considered (218) obligatory whenever separation of the deposit is feasible and unobjectionable, but it is a complementary auxiliary test, only significant in combination with other methods.

[3A.5] The above-mentioned method is recommended (218) as a means of examining the corrosiveness of a chemical "porosity" reagent towards the material (metallic and non-metallic†) of the deposit whenever it can be safely detached. A strip of the metal of a thickness comparable to that of the adherent deposit under investigation is separated from its base, and the visible pores are counted under the microscope over a given area, outlined, for example, with India ink. The specimen is then exposed to the reagent, preferably in contact with a strip of the base metal, and the same area is explored again. If the reagent is corrosive, it is very likely that the number of light-transmitting pores have increased, or the original pores have become enlarged, or new pores have appeared on areas where none were visible initially. A change in the pattern proves corrosiveness beyond doubt; an unchanged pattern is a strong indication even though not yet a rigorous proof of non-corrosiveness, more sensitive than any test for corrosion products, dissolved metal, or loss of weight. In the absence of a visible change, conclusive proof of non-corrosiveness is expected from a physical [3C] test now being developed (218) which consists in measurements of the rate of permeation of radium emanation through the porous foil. As this test is certin to express the degree of porosity irrespective of the shape of the pores, is very sensitive and safely non-destructive, its indications will be final.

[3A.6] In conclusion, reliable information on porosity is only likely to be obtained by combining safe methods of the [3B] class with those of class [3C], with checks of the type just mentioned.

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†See footnote to [3A.4].

3B. Methods of Detection of Individual Pores

$3B_1$. Ferroxyl Tests

[$3B_1$.1] Since its early application to electrodeposits [2.3], the ferroxyl reagent has been further developed and still ranks first for iron and steel-based deposits of metals nobler than iron either by nature or due to passivity, such as gold, silver, copper, tin, nickel, cobalt and chromium. For application to *nickel* coatings, (19) recommended, per liter, 1 g potassium ferricyanide, 10 g sodium chloride, 10 g agar. The sample is dipped in the warm liquid reagent for 3–5 minutes, withdrawn and allowed to cool in a horizontal position until solidification; this is said to be enough to develop the "maximum" (?) number of spots, and results are claimed to be consistent within 30 per cent. In reliance on the count of spots as tantamount to the number of pores, a numerical "protective value" was introduced by dividing 100 by the number of spots. In the discussion (19), however, it was pointed out that same samples tested at different times gave different results. Subsequent work in the same laboratory recognized the destructiveness of this reagent for nickel [$3B_1$.4]. The same was found (218) with 0.003 and 0.008 mm thick electrolytic nickel foil detached from stainless steel, both analytically and by the test set forth in [3A.5], the positive result of which is conclusive.

[$3B_1$.2] A variant of the foregoing method has since come into extensive use. It is designed to permit preservation of permanent records (29, 54) and makes use of a paper which has been thoroughly wetted with the above-mentioned ferroxyl reagent (or some other reagent composition) and dried before it is applied to the sample for a few minutes; the blue spots are printed on the paper which can be dried and filed. In this modification—henceforth to be referred to as a print method—the spots are said to be sharper than with the gel. Impregnation is facilitated by addition of 25 per cent alcohol. This reagent paper was also used (29) on nickel or chromium deposits over an intermediate copper coating on an iron base; pores reaching down to the iron print blue spots, those extending only to

the copper give reddish brown marks; when the paper has been moistened with ammonium citrate, only the latter spots remain. The particular reagent being corrosive for nickel, it is of course also inadmissible in a print method, particularly for composite copper-nickel deposits on iron. With regard to reagent print methods in general, it has been remarked (68) that inequalities in the spot pattern arise out of local concentration cells caused by unequal rate of drying. Also, since advance impregnation of the paper makes the amount of reagent taken up rather indefinite, and remoistening with an unspecified amount of water results in ill-defined and unknown concentration of the reagent (218), print tests can hardly be expected to be reproducible. Results obtained elsewhere with the 1 g/l ferricyanide, 10 g/l sodium chloride paper (without agar) are described as erratic (34).

[$3B_1.3$] Another method of application of a ferroxyl reagent, composed of 15 g agar, 6 g ferricyanide, 60 g sodium chloride, 250 cc alcohol, 100 cc water (51), consists in spraying at 120° F (49° C) for 2 minutes; the asserted non-corrosiveness of the test cannot be sustained. The same applies (218) to a 10 g/l ferricyanide, 5 g/l sodium chloride recipe (147).

[$3B_1.4$] Full realization of the destructive nature of the ferroxyl reagents so far described is expressed in the very thorough study (83): With regard to the sodium chloride content, it is asserted that its concentration "is not critical although stronger solutions accelerate attack of exposed steel". The concentration of ferricyanide "should be kept as low as possible and still yield blue spots". "In high concentrations of ferricyanide, nickel is attacked appreciably in the presence of sodium chloride and may, therefore, produce pores where the nickel is thin but not porous". Consequently, it is recommended to use a very small amount of ferricyanide, 0.5 g/l, with a high sodium chloride content of 60 g/l. This reagent is said to give "most consistent results". For permanent prints, 50 per cent white rag bond paper is soaked in the warm solution to which 10 g/l agar has been added, and allowed to dry; before use, the paper is soaked again in the reagent, this time without the agar, for 5 minutes and pressed against the sample at ordinary temperature for 5 minutes. This new reagent was again shown to be corrosive for nickel (224); electrolytic nickel foil 0.012 mm thick was severely attacked in one hour as shown by countless perforations seen in transmitted light. The number, if not the size, of the perforations was equally impressive with annealed foil. The same was found with somewhat thinner nickel foil both by microscopic inspection and analytically (218). Consequently, the high sodium chloride, low ferricyanide ferroxyl is unsuitable as a porosity reagent. Subsequent investigations, (154) in [$3B_1.7$], the same laboratory has fully confirmed this finding.

[$3B_1.5$] An extensive study of ferricyanide-sodium chloride combinations of widely varying proportions led (218) to the conclusion that the above (83) analysis of conditions of corrosiveness is not strictly valid. In experiments with 0.003 and 0.008 mm thick electrolytic nickel foil by microscopic inspection and analytically (218), nickel remained unaffected for days in pure 50–100 g/l ferricyanide solutions; consequently, it is not correct to state that high ferricyanide is a corrosive factor, and there is no point in so drastically reducing its amount. Likewise, pure concentrated sodium chloride proved to be harmless in still immersion. Rapid destructiveness sets in as soon as a high sodium chloride content is combined with a small amount of ferricyanide as in [$3B_1.4$], or in mixtures of medium contents of both sodium chloride and ferricyanide as in the older recipes, or with high ferricyanide in the presence even of fairly small—but not too small—amounts of sodium chloride. As an example of the latter, as little as over 0.5 g/l sodium chloride with 50 g/l ferricyanide will render the reagent corrosive for nickel; consequently, in the presence of a sizable ferricyanide content, the chloride concentration cannot under any circumstances be termed "not critical". On the other hand, while pure ferricyanide solutions fail to reveal pores, they are developed within some 10–20 seconds in nickel

deposits less than 0.010–0.020 mm thick in the presence of some 0.1–0.2 g/l sodium chloride. Addition of a very small amount of sodium chloride seems to be necessary to overcome passivation of the walls of the pores which impairs their wettability and hinders penetration of the reagent to the bottom. Reagents with 50 g/l ferricyanide and 0.1 g/l sodium chloride at *p*H above 6 do reveal pores and were ascertained not to be corrosive. With 0.5 g/l sodium chloride the reagent is unsafe. Corrosiveness is rapidly enhanced by heating, hence application of warm agar gels is highly objectionable.

[$3B_1.6$] Sodium chloride can be dispensed with altogether and replaced by sodium sulfate. Solutions of 50 g/l ferricyanide with from 0.5 to 50 g/l crystalline sodium sulfate gave no indication of corrosiveness for nickel foil in 2 weeks' still immersion (218). Porosity patterns are developed more slowly (about 2 minutes) than with sodium chloride reagents and are less dense. Equally non-corrosive but even slower in revealing pores are solutions of 50 g/l ferricyanide with from 0.5 to 50 g/l potassium nitrate. This latter reagent develops only a much weaker spot pattern in nickel over iron than either sodium sulfate or sodium chloride and seems, therefore, only to be active in pores of a particular type; there is hardly any variation with thickness between 0.003 and 0.024 mm (218).

[$3B_1.7$] The corrosiveness and hence the unsuitability of the high sodium chloride-low ferricyanide ferroxyl test reported from various quarters (129, 220) was conceded and demonstrated by one of its very authors (154) who showed that repeated application of the test on the same sample doubled the number of spots. A modified ferroxyl print method (154) seems at this stage to be unimpeachable from the point of view of possible attack on the nickel deposit. A 25 per cent rag bond paper strip is coated on one side with a warm (35° C) solution of 50 g/l sodium chloride, 50 g/l white gelatin and allowed to dry. Just before use, it is soaked again in a 50 g/l sodium chloride solution and applied to the sample for 10 minutes. When the paper has been removed from the sample and developed in a 10 g/l ferricyanide solution, pores in the deposit are reproduced as blue spots on the paper. This remarkable procedure avoids contact between the deposit and any ferricyanide-sodium chloride combination; the sample is only treated with pure sodium chloride which is non-corrosive for nickel (218, 224) but evidently able to dissolve iron and transfer it to the paper as ferrous chloride. Repetition of this modified procedure on the same sample gave unchanged spot patterns; application to a sample previously mistreated with the old, corrosive ferroxyl reagent left the last reading unaltered. Further experimental development of this "two stage" testing principle is indicated.

[$3B_1.8$] Ferroxyl reagents have been variously used on deposits of nobler, or passive, metals other than nickel on iron and steel. *Chromium on iron* tested (43) with 1 g/l ferricyanide, 10 g/l sodium chloride gave in 30 minutes more sharply defined spots and lines than with agar. Porosity of *cobalt and cobalt-nickel alloy deposits* (85, 111) is tested in the same way as that of nickel. Application to *gold* deposits *on iron-nickel alloys* is reported (219). For *silver on iron*, a composition of 0.79 g/l ferricyanide, 9.7 g/l sodium chloride and 9.75 g/l agar was employed (150) at 60° C with immersion for exactly 5 minutes. Use of ferrozyl gel was also reported by (176). Slight attack of silver by ferroxyl is reported for the rejected test (163); according to (143), the 60 g/l sodium chloride, 0.5 g/l ferricyanide reagent also attacks silver producing perforations in 0.001 inch thick foil in 30 minutes. The new two-stage print method [$3B_1.7$] deposits is accepted for silver (143). Ferroxyl has been used on *copper over iron* (7) since the very introduction of the reagent; the one-stage test is said not to be satisfactory, but the new two-stage print method is recommended (198 bis). Ferroxyl, occasionally used on *lead* deposits *over iron* (67), is said (198 bis) not to reveal as much porosity as a solution of 10 g/l ferricyanide and 20 g/l sulfuric acid (173 bis, 185) applied after washing the specimen with 10 percent sulfuric acid, spots appearing within one minute. Relatively extensive appli-

cations of ferroxyl methods are reported to *tin* coatings *on iron and steel*. The original Walker reagent [2.2] is said to attack tin (68); with gelatin added, fewer spots are counted than without it. With a reagent containing, per liter, 250 g gelatin, 15 cc of 10 per cent ferricyanide solution, 1 cc hydrochloric acid of sp. gr. 1.20, 25 cc glycerol, 0.5 cc chloroform (12, 115 bis) at 38 to 41° C, it was found that setting should occur within 10 to 15 minutes as the count varies with the rate of setting, that results obtained with different batches of gelatin cannot be compared, and that areas where alloying ($FeSn_2$) has occurred give blue spots with ferricyanide even when no pores are present. Another test is described (25 bis) in which the sample is treated with 5 per cent sulfuric acid for 2 minutes, rinsed, and exposed for 24 hours in a warm solution of ferricyanide with 7.5 g gelatin and 2.5 g glycerol per 100 cc. When a recipe (68) of 1 per cent ferricyanide, 0.5 per cent sodium chloride, said to be non-corrosive to tin, was used both in an immersion and paper print test, the print method invariably gave the higher pore counts. Also, pure 1 per cent ferricyanide failed to produce spots on 2 hours' immersion, but spots did appear when the pure reagent was used in paper. With sodium chloride contents higher than 0.5 per cent, the tinplate is attacked (68); interestingly enough, the number of pores revealed under these circumstances is lower than in the absence of attack. Paper soaked in 1 per cent ferricyanide, to be applied for 6 hours, is mentioned (86). Paper impregnated with 10 g/l ferricyanide, 5 g/l sodium chloride, 0.08 g/l Tergitol as wetting agent (187) gave fine spots so numerous that count was impossible and only the general appearance of the plate could be estimated. Another test (95) uses cellophane soaked for one minute in a 7 per cent ferricyanide solution with 7 drops of concentrated sulfuric acid per liter, drained, and applied for 45 minutes. There is no way of appraising all this wealth of reports without extensive experimental checks.

[$3B_1.9$] While most of the older ferroxyl reagents are provenly unsafe and the results obtained inconclusive, and while further confirmation is still needed for many other tests of the same type, newly developed ferroxyl methods [$3B_1.5$, 6, 7] appear to be demonstrably above the suspicion of being significantly corrosive for specific metal deposits. Consequently, the originally porous nature, particularly of deposits of nickel on iron, demonstrated by such methods can be considered as established beyond reasonable doubt.

(*To be continued*)

Society Publications in Libraries

The information given in the March, 1947 issue should be amended as follows:

*Library of Congress, Washington, D. C.
THE MONTHLY REVIEW, 1914—complete
Proceedings, 1930–1931, 1933—complete

John Crerar Library, Chicago, Ill.
THE MONTHLY REVIEW, 1914—complete

*Los Angeles Public Library, according to recent information, is equipped to supply photostat service and should have been marked with an asterisk.

With the exception of twenty issues supplied from the Executive Secretary's office, all missing issues for John Crerar Library were furnished by the late Mr. W. G. Bott, Sr., of Oak Park, Ill., and member of the Chicago Branch whose contribution is much appreciated.

We also gratefully acknowledge receipt of back issues of THE MONTHLY REVIEW during the past two months from the following:

HANSON-VAN WINKLE-MUNNING COMPANY, Matawan, N. J.
INDIVIDUAL DRINKING CUP COMPANY, Easton, Pa.
ST. LOUIS METAL CRAFTS, INC., St. Louis, Mo.
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BOOK REVIEWS

By DR. HAROLD J. READ
Associate Professor of Metallurgy
The Pennsylvania State College

INDUSTRIAL CARBON by C. L. Mantell, 1946, X + 472 pages. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York City. Price, $7.50.

Of all the elements in the periodic table, probably more has been written about carbon than any other—but most of the writing has concerned the compounds of carbon (organic chemistry) and fuel technology. Dr. Mantell has, however, discussed the industrial utilization of carbon as an element and, in the second edition of his useful book, has brought his treatment of the subject up to date. Since there are so few books in this particular field, it is gratifying to find that the volume under review is eminently satisfactory.

We do not have space to discuss individually the twenty-five chapters which comprise the book, but some indication can be given of the scope of the text.

The first chapters are devoted to descriptive matter on the naturally occurring forms of carbon and to the manufacture, properties, and uses of the several blacks—carbon, lamp and acetylene. A chapter on pigments presents this important use of carbon in a succint manner.

The electroplater will be particularly interested in the four chapters on the use of carbon as an adsorbent material since it is frequently used in the purification of plating solutions. It is unfortunate from the plater's viewpoint that there are substantially no specific references to the treatment of plating solutions. The value of this section of the book will be in the supplying of general background material.

The greater part of the text deals with the manufactured or fabricated forms of carbon. The raw materials, preparatory processes, etc., for the making of both the amorphous and graphitic forms of carbon are discussed in considerable detail. This section serves as an introduction to several chapters dealing with the production, properties and uses of a number of specific classes of manufactured items, namely, electrodes, brushes, arc light and illuminating carbons, carbon specialties and resistors, carbon as a material of construction, porous carbon, electronic tube anodes, and refractories. For these chapters on specific applications, Dr. Mantell has enlisted the services of several authors who are specialists in each of the several fields.

The last two chapters present a thoroughgoing resume of analytical procedures, testing methods, and physical and chemical properties. A compact, neat and extremely useful finding list for analytical and testing methods is included as the introduction to the chapter dealing with these subjects. Many tables of pertinent data are to be found in the section on physical and chemical properties. The former includes properties often described as mechanical, such as tensile strength, hardness, etc.

The text is abundantly illustrated with excellent line drawings and photographs which are, for the most part, quite satisfactory. It must be remembered, of course, that the photography of carbon objects is much akin to the old problem of photographing a black cat at midnight in the dark of the moon.

Both name and subject indexes are provided, and the author is to be congratulated on their excellence. There is nothing more gratifying about a reference text than to be able to find quickly and easily the material one is seeking.

How Many Strikes?

IF YOUR tanks go to bat with corrosion strikes already on them the final score won't be so good. Give them a break—a fair chance to stay in the game—by designing for corrosion resistance as well as for capacity.

Stortswelded tanks have been defeating corrosion—and giving the best service to customers—for more than twenty years. They have demonstrated that corrosion hasn't a chance against proper design.

Send your corrosion line-up to Storts for plans and proposals on tanks that stay in the game and help to win better profits.

STORTS WELDING COMPANY

42 Stone Street Meriden, Conn.

Manufacturers of Welded Fabrications to Specification

BALTIMORE-WASHINGTON BRANCH

The March meeting of the Branch was held at Reichart's Restaurant in Baltimore on the 12th. We heard two talks on unusual and interesting aspects of electroplating.

MR. KEARNS of the Bureau of Aeronautics spoke on "Deposition of Non-Metallic Coatings on Metals". He discussed the theory of plating non-metallic substances, such as rubber, ceramics, graphite, etc., on metal objects.

MR. IRVING CORTE of the Army Medical Center at Walter Reed Hospital spoke on "Electroforming of Molds for Cosmetic Gloves from Flexible Positives". Mr. Corte has developed a process for electroforming permanent metal molds from plastic forms for making artificial hands for war amputees. He exhibited interesting plastic gloves made from the electroformed molds that showed a surprising degree of reproduction of detail.

Extreme interest was shown with nearly all of the forty-six present entering into the discussion. GRACE RIDDELL, *Secretary.*

●

BRIDGEPORT BRANCH

Twenty-eight members and guests were present at the March 7 meeting.

PRESIDENT GOLDMAN reported on the progress of the Regional Meeting Committee. FRANK J. KALAFUS, Chairman of the Exhibit Committee advised that Hotel Statler has allocated space for the Branch exhibits. The Research Committee for Sustaining Memberships had contacted thirteen firms by letter.

Two new members were elected and one was received by transfer.

After a thorough discussion, President Goldman appointed the following to study the "Revision of the Constitution of the A. E. S." and report at the next meeting: ARTHUR MCNEIL, RAYMOND J. KWASNIK, CARL SCHAEFER, WILLIAM EHRENCRONA, FRANK KALAFUS, CHARLES L. TEMPLE.

JOSEPH G. STERLING,
Secretary-Treasurer.

●

BRIDGEPORT BRANCH

The members of the Bridgeport Branch were the guests of The Electrolux Corporation in its Old Greenwich plant on March 21. This meeting was the most successful and enjoyable meeting ever held, and we wish to thank MESSRS. MILTON HODGES and WILLIAM MURRAY, Finishing Superintendent and Works Manager, respectively, for their generosity and helpfulness.

Following a delicious dinner served to the 106 members present by The Electrolux Corporation, the members visited the plating and finishing departments. They are among the most modern and well kept in this section of the country. One of the most interesting sights was the disposal system for plating room waste. It is the first of its kind in the country and was installed through the combined efforts of the Corporation, MR. COPELAND, PROFESSOR HOOVER, and MR. WILLIAM WISE of the State Water Commission.

The waste waters are pumped into eight 20,000-gallon tanks where it is treated with chemicals and allowed to settle for several hours. The water is then siphoned off and the sediment pumped into trucks and carted away.

The evening was highlighted by a talk by MR. WILLIAM WISE of the State Water Commission. In his very informative and interesting presentation he stated that the State of Connecticut is working on a disposal system that will not only treat the waste but will recover many of the valuable materials that now go down the sewer.

Out-of-town members included our old friend and former member, RALPH MCCAHAN, chairman of the waste disposal project of the Research Committee, and DR. FRED GURNHAM and MR. D. C. RHEEMS who are working on the research project at Yale University.

JOSEPH G. STERLING,
Secretary-Treasurer.

●

BUFFALO BRANCH

The Buffalo Branch held its regular monthly meeting on March 14 with Vice-President DR. C. J. WERNLUND in the chair.

The Delegates to the Convention were instructed to vote no on the proposed Constitution change.

A committee consisting of B. KIRCHOFF, A. LAMPRECHT and K. SHUMWAY was appointed to arrange the summer picnic.

WILLIAM FOTHERINGHAM reported that the Buffalo Public Library will subscribe to THE MONTHLY REVIEW.

LIBRARIAN C. LOGAN introduced MR. W. H. JACKSON of The Udylite Corporation, Detroit, Mich., who gave his very interesting lecture on "Horizontal Plating Barrels and Auxiliary Equipment" (THE MONTHLY REVIEW **33,** 1162 (1946)). The many questions asked by the members were promptly answered by Mr. Jackson.

J. RUFF, *Secretary.*

●

CHICAGO BRANCH

About one hundred members and guests were in attendance at the regular meeting on February 14.

MR. O. B. GORDON of Behr-Manning discussed the wide variety of uses of coated abrasive belts for polishing, a subject of special importance at this time because of the difficulties experienced in obtaining glue for set-up polishing wheels. Mr. Gordon first outlined the methods and gave a detailed description of the abrasive grain sizes available in polishing belts and also the dimensions of the belts which can be furnished promptly. He then touched upon the comparative length of life of abrasive belts and set-up polishing wheels, which he, in his experience, had found very favorable. Details of the type of lubricants which he had found satisfactory for use with belts were presented. Certain equipment supplementary to the polishing lathe are required: a back stand idler, and wheels used in conjunction with the belts. The wheels may be rubber base, felt, or pneumatic. The method lends itself well to strapping operations.

After the meeting, Mr. Gordon and three other gentlemen from Behr-Manning, MESSRS. THORSON, SALMONS and BROOKS, gave a practical demonstration of belt polishing methods on a small lathe which they had set up in the hall.

That interest in this method was considerable was shown by the discussion that followed and the attention which was paid to the practical demonstration.

The question box was quite well loaded also.

G. STUART KRENTEL,
Review Correspondent.

●

CHICAGO BRANCH

At the regular meeting on March 14, one of our members, MR. ERNEST H. LYONS of the Meaker Company, showed moving pictures which he had taken on a trip into Utah. He had made an extensive pack trip on horseback through some recently opened country and his scenic shots made a good many of the assembled members quite dissatisfied with Chicago; however, since he did not run across a single plating shop in three weeks, the question was raised as to what a displaced plater would live on. No satisfactory answer was returned to this question.

The question box was well loaded and some interesting discussions ensued.

We had some ladies as guests and, in addition, refreshments after the meeting.

G. STUART KRENTEL,
Review Correspondent.

●

COLUMBUS BRANCH

There were fourteen members and six guests present at the regular monthly meeting on April 4 in the Battelle Auditorium. The feature of the evening was a movie and talk presented by MR. J. W. MCCRACKEN

of the Mine Safety Appliance Company on the development and use of respirators for industrial workers.

A business session was held at which the main topic of discussion was the proposed new constitution. The Board of Managers, C. L. FAUST, L. L. HAAS, and W. J. NEIL presented a report of their study oi the matter. A motion was passed instructing the Board to prepare a letter to the National Society presenting certain objections to the constitution as now published.

A Nominating Committee composed of WALTER DENNY (Chairman), W. P. RUEMMLER and C. J. SLUNDER was appointed to prepare a list of candidates for next month's annual election meeting. This meeting will be held on May 2 at Hoffman's Gardens. Dinner will be served at 7:00 P. M.

CLOYD A. SNAVELY,
Second Vice-President.

●

DAYTON BRANCH

At the regular meeting on March 14, PRESIDENT MOLINE commended the committees on the successful Second Annual Educational Session and Dinner Dance.

MR. WILLIAM NEILL of the Columbus Branch was Honorary Chairman of the well-attended afternoon Session. Speakers were MR. W. B. STODDARD who discussed "Basic Problems in Electroforming", DR. B. AGRUSS whose topic was "Alkane Sulfonic Copper Plating", and MR. JOHN BEAVER of the Dayton Branch who presented "Copper Plating by the Day-Brite Process". Each of the speakers were well informed on their subjects, and many questions were asked the speakers after the meeting. The evening Dinner and Dance was a very happy affair and everyone attending really enjoyed himself.

S. C. PUTZAN then introduced MR. B. G. BOWMAN of the Standard Steel Spring Company who gave a paper on "Corronizing". Following a discussion of the process, the industrial uses to which it is put, and its advantages, Mr. Bowman presented slides of actual plant layouts. Many questions were asked by the members.

RALPH CLINEFELTER,
Secretary-Treasurer.

DETROIT BRANCH

The March meeting was held on Friday, March 7.

Following the election of a half dozen men to membership, PRESIDENT WILSON called upon WALTER PINNER, Chairman of the Nominating Committee, to present its slate for next year's Officers. It included the incumbents and, in addition, GEORGE NANKERVIS for the First Vice-Presidency. The following were nominated to the Board of Managers: EDGAR W. JONES, WALTER PINNER, and CLEVELAND NIXON. Nominating slips will be mailed to all members so that they may add their nominations prior to election at the next meeting. CARL HEUSSNER and CLEVELAND NIXON were nominated to be Delegates to the June Convention.

Mr. Nixon was appointed chairman of a committee to study the proposed new Constitution and abstract it so that each member may have the essentials and be able to vote intelligently on instructions to the Delegates.

Following the presentation of the motion picture, "The Story of Nickel", courtesy The International Nickel Company, which proved to be very interesting and instructive, LIBRARIAN PILLSBURY introduced our old friend MR. GEORGE HOGABOOM, SR., who spoke on "Notes on the Cleaning of Steel". As usual, Mr. Hogaboom's talk was thoroughly interesting, and many valuable points, gained from his years of experience in the plating industry, were passed on to us. He stressed the need for knowing what soil is being removed in cleaning operations and its effect on the cleaning solutions, the importance of the ratio of silica to caustic in silicate cleaners, and the trouble that can be caused by sulphur bearing materials in drawing compounds. He also mentioned that a great deal of trouble has been caused by invisible oxides on apparently clean steel surfaces and mentioned the copper sulfate test as a practical one to determine when a surface is chemically clean.

A very lively question and answer period followed.

R. H. DUDLEY,
Publicity Chairman.

DETROIT BRANCH

The April meeting of the Detroit Branch was held as usual at the Hotel Statler on April 4, PRESIDENT WILSON presiding.

All of the present Officers were re-elected for a second term, with GEORGE L. NANKERVIS filling the vacancy left by the death of PAUL STRAUSSER. Board of Managers for the ensuing year were elected and delegates for the June Convention were chosen.

George L. Nankervis gave a short progress report on the convention plans and the arrangements being made for the Industrial Finishing Exposition.

Last year's World Series motion picture was to be presented, but through some strange alchemy of Briggs it turned out to be a picture presenting their Beauty-Wear bathroom fixtures.

MISS GRACE RIDDELL of the National Bureau of Standards spoke on the subject of "Electrodeposition of Tungsten Alloys". Three main alloys were touched on: tungsten-nickel, tungsten-cobalt and tungsten-iron. Curves were presented showing conditions for various percentages of tungsten in the alloy deposits. The anode efficiency of these baths is 100 per cent and the cathode efficiency is 60 to 85 per cent depending upon the alloy and system used.

MISS GENE KELLOGG presented a very fine paper on "A Magnetic Gauge for Measuring Composite Copper-Nickel Coatings". It was very interesting to note that a method has been developed whereby the thickness of the individual layers of composite coatings may be determined. This should meet wide acceptance in the plating industry.

Following the meeting refreshments were served to the enjoyment of all.

R. H. DUDLEY,
Publicity Chairman.

●

GRAND RAPIDS BRANCH

Four applications for membership were received at the Branch meeting on February 14.

A report was made on the Annual Educational Session and Dinner Dance sponsored by the Branch on February 1. MR. FRANK SAVAGE, A. E. S. President, was Chairman of the Educational Session which he handled graciously and efficiently. The speakers for the Session presented papers of highest caliber—MR. WALTER MOLINE on "Electrolytic De-Burring", MR. CLEVELAND NIXON on "Notes on Nickel and Chromium Plating", and MR. MAURICE R. CALDWELL on "Recent Developments in the Finishing of Zinc Base Die Castings". The Session was well attended, and a lively discussion period followed the presentation of the papers.

The Dinner Dance, held later in the evening, surpassed all past standards, and those attending had a wonderful time.

MR. JOSEPH MAZIA, our speaker at the February 14 meeting, presented a well-prepared paper on the development of electrolytic polishing. He mentioned all of the better known applications, the solutions used, and the precautions to be observed in their use He also referred to certain other solutions which have a brightening or polishing effect surpassing that of the conventional bright dip but which do not require electric current. A short discussion followed. Those attending derived considerable benefit from Mr. Mazia's talk.

Following adjournment, the hotel served the usual refreshments.

RANSON B. PERKINS,
Secretary.

●

HARTFORD BRANCH

The March 17 dinner meeting of the Hartford Branch was enjoyed by fifty members and guests. GEORGE HOGABOOM, introduced by TECHNICAL CHAIRMAN RALPH MCCAHAN, did a splendid job of pinch-hitting for GEORGE JERNSTEDT, originally scheduled to speak at this meeting. Mr. Hogaboom, a pioneer in this field of finishing, spoke on "Plating on Glass and China". He covered the subject well, giving a rather complete history of the progress of the art from its beginning to its present position. After he had been given a rising vote of thanks, the meeting was adjourned and refreshments were served.

F. W. SMITH, *Secretary.*

●

LANCASTER BRANCH

The regular monthly meeting was held on

March 14 in conjunction with an afternoon visitation to the plant of the Bethlehem Steel Corporation in Steelton, Pa. Among the interesting things we saw during the three-hour tour through the plant were the rolling of railroad rails, the tapping of a blast furnace, and the operation of an open-hearth furnace.

After a delicious dinner in Shelleys' Restaurant in Steelton, we met at the Aircraft and Marine Corporation Laboratory in Harrisburg, Pa., with forty-nine members and guests present. It was voted to cancel the Ladies' Night affair planned for April. PRESIDENT HAROLD KILHEFFER appointed the following to the Nominating Committee: ROLAND HOENSTINE, Chairman; WILLIAM FORDNEY and KARK NUSS.

Our speaker, MR. M. I. JACKSON, Philadelphia District Manager of Behr-Manning Company of Troy, N. Y., was introduced by CHARLES SNYDER. Mr. Jackson who spoke on "Belt Polishing" pointed out that it was started in 1940 but did not become popular until 1948. Many polishing jobs could be handled faster, more efficiently and cheaper by the belt method. Unlike headed-up wheels, polishing belts are not susceptible to changes in atmospheric conditions. The contact wheels used in belt polishing are now contour shaped to polish curved articles.

After his talk, Mr. Jackson showed us a movie of the manufacturing of Abrasive Belts. He also displayed several types of back stands, contact wheels and abrasive belts.

After the meeting adjourned, we were treated to refreshments by Charles Snyder.

H. CLAY BRUBAKER, *Secretary.*

●

LOS ANGELES BRANCH

The Los Angeles Branch held its regular meeting on March 10 in the Elks' Club, where seventy-two dinners were served and an estimated ninety-five persons attended the meeting.

Following the dinner, PRESIDENT D. N. ELDRED opened the meeting with a dissertation on "Perchloric Acid in Plating Shops". The O'Connor explosion resulted in a thorough investigation of hazards in plating shops. He advised that stores of chemicals be segregated in accordance with their hazards, that handling of acids be permitted only under proper supervision and by authorized and competent individuals, that the foremen be responsible for the chemicals, that safety practices be inaugurated and, last but not least, that the shops be cleaned up.

MR. WALLACE G. IMHOFF, President of the Wallace G. Imhoff Company, then delivered a paper on "An Interpretation of the Action of Inhibitors in Pickling". Mr. Imhoff reviewed the pickling art back to its beginning in 1806 and presented a comprehensive list of references on pickling inhibitors.

MR. STERLING PRATT of the National Carbon Company described the physical, chemical and engineering properties of Karbate equipment and exhibited Karbate fittings. A general discussion on both papers followed.

President Eldred, speaking for his committee on the revised Constitution, reviewed briefly its meeting of March 3. The findings will be written up and forwarded to the National Committee and a report made to the Branch at its next meeting. SECOND VICE-PRESIDENT FRANK BUNKER'S offer of the facilities of the L. H. Butcher Company cafeteria for the May meeting, including a buffet lunch, was gratefully accepted.

President Eldred announced his appointments of committees for the Annual Educational Session and Dinner Dance scheduled for March 22, as follows:

EDUCATIONAL SESSION

Chairman: LIBRARIAN GILBERT EXTALE
Reception and Registration: JOHN MERIGOLD, ERNIE FRANCIS and ED WILLIAMS
Ticket Sale and Collection for Luncheon: RAY BRAY, AL SULZINGER and JOE SUNDERHAUS

DINNER DANCE

Tickets and Reservations: EMMETTE HOLMAN, ED WELLS and AL SULZINGER
Table Arrangements, Reception and Seating: CLARENCE THORNTON, MARCUS RYNKOFS and EARL COFFIN
Entertainment: HOWARD WOODWARD

Exhibits and Door Prizes: FRANK BUNKER and DON BEDWELL

E. R. HOLMAN,
Secretary-Treasurer.

●

MONTREAL BRANCH

The Branch held a regular meeting in the Mount Royal Hotel on March 4, with 13 members and two guests present. The Executive Secretary's letter on the use of perchloric acid was appreciated by all as an example of how the Supreme body is working for the benefit of all members.

LIBRARIAN J. T. REISENBERG then continued the discussion begun in January which this time centered around plating room hazards and the indiscriminate use of chemicals by some platers. It was generally agreed that not only should more attention be paid to the dangerous chemicals but also to the proper use of any chemical.

A committee was selected to study the proposed revision of the Constitution. A Branch Exhibits Chairman was appointed. A Nomination Committee was proposed and accepted.

One new member was elected and there was one application for membership.

WILLIAM GLOVER, *Secretary.*

●

MONTREAL BRANCH

Twenty-two members and six guests were present at the regular April meeting, a record for the Montreal Branch.

After the usual preliminaries, the chair was turned over to the librarian who introduced MR. H. W. SUSSMAN of Columbia Electric Manufacturing Company who spoke on "The How and Why of Tank Rheostats". This was the first time the Branch had been addressed on this subject. The interest shown by all present indicated their appreciation of the speaker and his efforts. A hearty vote of thanks to Mr. Sussman.

There was one election and one member suspended for non-payment of dues.

A new slate of officers was unopposed and unanimously elected.

MR. J. H. FEELEY asked convention delegates to meet and study the new constitution.

WILLIAM GLOVER, *Secretary.*

NEW HAVEN BRANCH

The New Haven Branch held its "January Social" on the 14th in Hotel Taft.

PRESIDENT JOE COOKE welcomed the members and guests and introduced the speaker SIG HAGEN, a former Minnesota lumberjack who spoke of his experiences following the footsteps of the famous Paul Bunyan.

The lucky members extend their thanks to the following firms for their door prizes: *Fred Gumm Chemical Company, Wyandotte Chemical Corporation, Lea Manufacturing Company, Enthone Company, Hanson-Van Winkle-Munning Company, MacDermid, Incorporated, La Salco, Inc., and Industrial Filter Company.*

Pretzels, beer and potato chips gave the members pep to sing a new verse to our "Red Wing" song led by HANK KELLNER and accompanied by CHARLIE KOELBL on the piano.

The Platers Quartet consisting of JACK GORMLEY, leader, DOC GARNER, DICK JOHNSON and JIM CREAMER was voted the best in New England by judges JACK ENGLISH and AL JAEKLE. A genial good time was had by all.

B. J. GAFFNEY,
Secretary-Treasurer.

●

NEW HAVEN BRANCH

PRESIDENT JOE COOKE opened the February 11 meeting and had CHAIRMAN KELLNER of our New England Region bring the members up to date on the plans for the coming affair. The meeting was then turned over to TECHNICAL CHAIRMAN GEORGE KNECHT who joined the members in extending to MR. MYRON DIGGIN of Hanson-Van Winkle-Munning Company a healthy welcome.

Mr. Diggin's subject, "Periodic Reverse Plating", has aroused much interest in the plating field through its possibilities. The speaker covered his subject thoroughly and received a rising vote of thanks for delivering another of his interesting technical talks on new plating procedures which always are valuable information to the plater.

B. J. GAFFNEY,
Secretary-Treasurer.

NEWARK BRANCH

The Newark Branch held its Annual Open Winter Educational Session on March 7 with a "Symposium on Electropolishing". PRESIDENT JOHN DE VRIES opened the meeting and LIBRARIAN ZACHARY IRENAS introduced the speakers.

MR. ALBERT HOWE of Federal Telephone and Radio Corporation and a member of Newark Branch spoke on "An Introduction to Electropolishing". Using the phosphoric-sulphuric acid bath, he had electropolished all types of metals such as steel, copper, aluminum and stainless steel. Irregular shapes and sizes lend themselves well and are polished all over. The work may be done in full automatics on such items as chain or wire. Mr. Howe has patented a method of electropolishing in a barrel. The copper contacts in the barrel become passive after the first two minutes and the work, being in contact with the copper at all times, polished very nicely without affecting the copper contact.

MR. WILLARD HULTS, Manager of Schnefle Brothers Company, also a Newark Branch Member, had for his subject, "The Economic Aspects of Electropolishing". With the phosphoric-sulphuric-chromic acid solution, irrgularities in the brilliance of the finish became apparent in relatively flat surfaces. The amount of metal removed is about 2 to 4 per cent by weight when articles with points, such as some surgical instruments, are electropolished. An allowance should be made for the removed metal so that the desired point be obtained. Mr. Hults passed around numerous elecropolished samples of nail files, tweezers, wire mesh and dental forceps together with samples that were not electropolished to show the difference in finish. He gave in detail the savings on parts which are almost impossible to buff, and even then do not have a very high lustre.

MR. KENNETH HUSTON, of the Rustless Iron and Steel Company of Baltimore, Md., and A. E. S. First Vice-President, discussed "Electropolishing of Stainless Steel" with citric-sulphuric acid electrolyte. A newly made solution has a tendency to solidify on cooling but goes back into solution on reheating. When it has picked up enough metal it will not solidify. Many stainless steel articles are being electropolished, such as refrigerator trays and racks, kitchen utensils, surgical instruments, toaster doors, tubing and pipe fittings. The cathode is lead, the voltage of 6 to 12 volts, the current density 70 to 250 asf, the temperature 185° to 200° F. An assistant polished samples brought by the members during the talk, and later gave out samples of electropolished paper clips.

An open discussion of all three papers followed, and each speaker answered the questions addressed to him. The members were then invited to partake of the refreshments donated by the Oakite Company. This meeting had the largest attendance of the 1946–1947 season.

GEORGE REUTER, *Assistant Secretary.*

●

PHILADELPHIA BRANCH

The Branch had one of their usual Broadwood Hotel dinner meetings for March with all the officers and some sixty members present. NAT VERRELLE and his assistant HARRY BROWN did a good job with the dinner arrangements and the refreshments.

At the request of LIBRARIAN HIRSCH, PRESIDENT ORLIK introduced MR. EDWIN F. OTTENS, Plating Chemist with the Philco Corporation and a member of our Branch, whose subject was "Chromate Coatings for Zinc and Cadmium".

Having predicted that the scarcity of cadmium would continue, the speaker gave a very interesting survey of the use of such chromate coatings as Cronak, Iridite, and Anozinc on parts zinc plated with the now widely used high speed solutions. He also presented accelerated methods of testing and evaluating the coatings so that the members may advise their customers as to the best finish for the particular type or use of the article. The value of the bright dips for the continued use of zinc plating and the use of chromate coatings as a base for organic coatings were also stressed. President Orlik led the branch in a rising vote of thanks for Mr. Ottens.

Three applications were referred to the Board of Managers and five approved appli-

cants were elected to membership, along with an in-transfer.

The members had a fine time talking shop and visiting from group to group during the balance of the evening.

PAUL MENTZER, SR., *Secretary.*

●

PITTSBURGH BRANCH

The regular monthly meeting was held at the Keystone Hotel on February 20 and was preceded as usual by a dinner. Due to very heavy snow, the attendance was reduced to sixteen at the dinner and twenty-five at the meeting.

DR. D. T. EWING of Michigan State College was the principal speaker and gave an interesting account of some of the work he is carrying out under the sponsorship of our Society on methods of detecting and removing impurities in electroplating solutions. Following the presentation of his talk, he replied to a number of questions on specific problems brought up by those present.

R. A. DIMON continued his series of talks on the general subject, "Fundamental Principles Underlying Electroplating" with a discussion of "Porosity".

An exhibit of decorative plating was shown by the Pittsburgh Refinishing Company.

RICHARD A. DIMON,
Secretary-Treasurer.

●

SAN FRANCISCO BRANCH

A regular meeting was held in the El Curtola Restaurant in Oakland on February 20 with twenty-one members and five guests attending.

It was decided to proceed with the class in electroplating and divide it into two sections, each to meet on one side of the bay.

The President recommended that a membership drive be undertaken and appointed STANLEY COLE chairman and J. LESIRE, A. KISTLER and R. SORRELLS members of the Membership Committee.

One applicant was elected to membership.

An address was delivered by MR. GEORGE WILKENS of the General Chemical Company on "Copper Fluoborate Plating Solutions". Slides were shown, and samples of lead, tin, copper, zinc, cadmium and nickel deposited from fluoborate plating baths were passed around.

FRED W. HUNTINGTON,
Secretary-Treasurer.

●

SAN FRANCISCO BRANCH

Twelve members and five guests attended the regular meeting on March 20 in St. Julian Restaurant, San Francisco.

Three applicants were duly elected to membership.

MR. RUSSEL HEDEEN of the Ryman Manufacturing Company delivered a talk on grinding and polishing with back stand idlers and abrasive belts. Special consideration was given to the many practical applications of the method in job shops and manufacturing plants. A bench grinder of this type was displayed, and samples of work were passed around. Mr. Hedeen supplied cost figures for the equipment and operation.

MR. H. A. MAIHEN of the Pacific Abrasive Supply Company discussed abrasive belts and abrasives. Members were invited to visit the experimental shop in San Francisco and try samples of their own work on this equipment. FRED W. HUNTINGTON,
Secretary-Treasurer.

●

SOUTHEASTERN BRANCH

The regular monthly meeting was held on March 13 in the Pullman Shops after a very nice Dutch lunch which was enjoyed by all.

EXHIBITS CHAIRMAN WOOLFOLK asked for information as to what could be expected from the Branch in the way of an exhibit. Our May meeting is to be held in Birmingham.

Four new members were elected. One hundred members before June is the goal.

MR. BALTZELL of Oakite Products offered the branch a display in their exhibit at the Metal Show to be held in Atlanta in April. MESSRS. DEUTSCHMAN, STOGNER amd CARTLEGE are to meet this month to decide on the arrangements.

WILLIAM T. WEYMOUTH,
Secretary-Treasurer.

●

ST. JOSEPH VALLEY BRANCH

Twenty-one attended the dinner and

twenty-six the technical session on February 6.

Two applications were voted upon and accepted.

CARL SMALLWOOD, R. D. WYSONG and JOHN LOCKERBIE were appointed to serve as a Nominating Committee, with Mr. Smallwood as chairman.

LIBRARIAN H. J. WIESNER introduced MR. MYRON B. DIGGIN of Hanson-Van Winkle-Munning Company, Matawan, N. J., who gave a very interesting talk on the new subject of periodic reverse plating.

RAYMOND A. FRIEND, *Secretary.*

●

ST. JOSEPH VALLEY BRANCH

The January 8 meeting of the St. Joseph Valley Branch was held in the City Club Room of the Hotel Elkhart, Elkhart, Ind. Twenty-three attended the dinner and thirty-one the technical session which followed.

One applicant was received into membership. Two new applications were read and one in-transfer from the Chicago Branch.

LIBRARIAN H. J. WIESNER introduced DR. R. B. SALTONSTALL of the Udylite Corporation, Detroit, who read a paper covering the major points of plating-room maintenance. It was followed by a general discussion of the subject.

RAYMOND A. FRIEND, *Secretary.*

●

SPRINGFIELD BRANCH

The March meeting on the 24th was presided over by VICE-PRESIDENT JOHN COSTIGAN. Three applicants were received into the Society.

Mr. Costigan introduced MR. ARTHUR ZAVARELLA who gave a talk about Jernstedt's "Reverse Polarity Plating Process".

The guest speaker, MR. L. A. CHESWORTH of Carr Fastener Corporation, Boston, Mass., was introduced by the Chairman of the Library Committee, JOHN HORRIGAN. Mr. Chesworth spoke about barrel plating of bright zinc and nickel. Question periods followed each of the interesting presentations.

The laughs of the evening were furnished by COLIN HASTIE who made a motion that the Society buy the beer. Ten minutes later, Mr. Hastie arrived with a washtub full of iced beer. Mr. Hastie poured.

Sentiments were that this had been a pious, maleductive (*Editor: page Mr. Webster!*), good meeting.

LAURENCE R. FOUNTAIN,
Secretary-Treasurer.

●

SYDNEY BRANCH

The March 12 meeting opened at 8 P. M. with the President in the chair and seventeen members attending. There was one reinstatement.

W. PATTERSON was appointed Social Chairman with six members to help him organize the 1947 function. This committee will have about seven months to ensure the next Social night is as successful as the 1946 Smoko.

MR. W. MILLWARD of Amalgamated Wireless of Australia gave an interesting talk on "The Use of Bi-Polar Anodes". MR. PEACH, formerly of the British Research Laboratories, was present as a visitor and had many questions to ask the speaker who ably answered the majority of them.

After the lecture the President gave a few extracts from the results of the British Government's research into the electroplating industry in Germany which demonstrated that the U. S. A. and England were far in advance of Germany in the science of electroplating.

The Question Box followed with questions so interesting that the members did not leave until the meeting adjourned at 10:30 P. M. J. R. GODFREY, *Secretary.*

●

SYRACUSE BRANCH

MR. M. BOLAND won the door prize, a copy of Simonds and Bregman's book *Finishing Metal Products* at the dinner which preceded the March meeting.

A report of the Branch Research Committee was followed by a discussion of the progress made.

One applicant was elected to membership.

The new Constitution was analyzed by the committee appointed for this purpose. PAUL SWARTZ and R. NORTON outlined the Constitution, emphasizing changes from the original. GEORGE SIMMONS gave his opinion

of the advantages and disadvantages of the changes involved. The comments aroused considerable discussion and will be summarized for action at the next meeting.

The attendance was seventeen.

N. F. MURPHY, *Secretary.*

●

TOLEDO BRANCH

The February 6 meeting was opened by PRESIDENT MAYNARD GEIGER with sixteen members present.

MICHAEL SPANOLIS was proposed for honorary membership in the Branch. Final action will be taken at the April meeting.

LIBRARIAN NOE conducted a question box which brought out that (1) Cadmium can be plated over galvanized steel following mild cleaning in a die cast cleaner; (2) The Aluminum of America, New Kensington, Pa., should be contacted for information concerning anodizing and dyeing aluminum in one operation; (3) Hydrogen embrittlement relief of cadmium plated work can be had without discoloration by treatment at 300° to 500° F in controlled atmosphere furnace; (4) Aluminum casting may be buffed with special buffs and compounds if one has made certain that no salts are present during the operation; (5) 30 per cent hydrofluoric and nitric acid make a good bright dip for brass or bronze coatings; it should be kept in a Koroseal lined container.

Refreshments were served after the meeting, and the remainder of the evening was spent playing cards.

G. H. BERGEMAN, *Secretary.*

WATERBURY BRANCH

BERT SAGE opened our regular monthly meeting on February 14.

DR. GEORGE DUBPERNELL reviewed the latest issue of A. S. T. M. Specifications and Tests for Electrodeposited Coatings prepared jointly by the A. E. S. and A. S. T. M. This important booklet is now more complete than previously.

HENRY STROW, in discussing new developments, dwelt briefly on the use of electron diffraction to detect films in the cleaning of metals for electroplating.

Our movie for the evening was a General Electric film showing how a televised picture is produced from the time the image is picked up in the studio until it is projected on the screen in the home.

TONY MAZ introduced DR. R. B. SALTONSTALL, Technical Director of the Udylite Corporation, Detroit, Mich., who discussed "Maintenance in the Plating Room". Dr. Saltonstall pointed out that maintenance in the plating room is of particular importance because of the severe conditions of corrosion. It is all too often neglected until a bad breakdown takes place. He went carefully over each type of equipment, detailing the steps necessary to keep it in first-class condition. At the end of the paper there was an extensive question period during which numerous troublesome maintenance problems were discussed.

SPENCER L. HENN,
Secretary-Treasurer.

THIRD INTERNATIONAL CONFERENCE ON ELECTRODEPOSITION HELD IN LONDON

The Electrodepositors' Technical Society is sponsoring the Third International Conference on Electrodeposition which is being held in London, England, on May 1–3, 1947.

According to the Society's President, Dr. S. Wernick, a number of papers will be presented by Continental authors. Several American authorities have also been approached for contributions. Dr. R. M. Wick will have a paper on the A. E. S. Research Program. Dr. Abner Brenner and Mr. George B. Hogaboom have planned to attend and present their papers in person.

The first conference of this kind was also held in London in 1937, the second in Asbury Park, N. J., in 1939. It is gratifying that our British friends have revived this custom so soon after the conflict to exchange ideas and renew old friendships. We wish the meeting all success.

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By KENNETH M. HUSTON

Chairman, Program and Educational Committee

Calorizing

B. J. SAYLES. *Corrosion and Material Protection* **3**, No. 7, 11–12 (1946).

Calorizing is a process for impregnating the surface of steel to create an iron-aluminum alloy which protects the steel against high temperature oxidation and corrosion by gaseous sulfur compounds found in the flue gases of fuel-fired furnaces. The surface alloy also provides a high degree of immunity to carburization. Calorizing is not resistant to weather corrosion.

The process is conducted by packing the parts in a powdered compound in which powdered aluminum is the active ingredient and heating to 1800° F. Pipe and tubing are processed in cylindrical rotating retorts while articles of irregular shape are packed in stationary boxes. It is customary to heat treat alloy steel tubing following calorizing to restore grain structure and physical properties of the base material. Control of calorizing compound and of time and temperature of both the calorizing operation and the subsequent heat treatment makes it possible to exercise a fair degree of control over the depth and the aluminum content of the alloy. The slight build-up of the surface due to the calorizing operation is not under perfect control. Generally speaking, calorizing should not be attempted on steel lighter than 12 gauge. With gauges much less than No. 12 B. W. G., it is usually more economical to employ stainless steel sheet.

L. H. SEABRIGHT.

Anodized Domestic Ware

MAX SCHENK. *Light Metals* **9**, 575–592 (November 1946).

A lengthly paper discussing every aspect of anodizing of pots and pans, as well as equipment for hospitals, general kitchen equipment, and various types of ornaments such as vases and ash trays.

•

Sprayed Aluminum for Corrosion Prevention

A. F. SHEPARD. *Aluminum and Magnesium* **3**, 6–9, 24 (November 1946).

A brief description of equipment for metal spraying and the process of applying it. Advantages of spray coatings and costs are considered. Numerous examples are given of successful applications.

•

Surface Finishes for Wearability: Testing Light Metals

ARTHUR P. SCHULZE. *Modern Metals* **2**, 24–26 (November 1946).

The development of a testing machine for predicting the abrasion resistance of coatings is outlined. The Taber Abraser duplicates in measurable terms the rubbing abrasion that a finished surface encounters in actual service. Testing procedures are described in some detail.

Metal Finishing Requirements of the Automobile Industry

J. Electrodepositors' Tech. Soc. **21**, 149–170 (1946).

H. H. JACKSON, "Aspects of Finishing Processes to Automobile Engines and Chassis": This paper deals solely with plating for minimizing wear. It discusses the use of silver and chromium for bearings, copper plating and manganese phosphate coatings for gear teeth, electropolishing, and electrolytic production of metal powder for use in powder metallurgy. J. R. STANFIELD, "Body Corrosion Troubles": Current practice in preventive measures for internal body corrosion is reviewed, and possibilities for improvement are considered. V. PAGE, "A Motorcycle Manufacturer's Views on Finish and Protective Coatings": Appearance and durability are both most important on motorcycle parts. Present finishes on various parts are reviewed and, in some cases, the need for a better finish is pointed out. S. WERNICK (in discussion) laid stress upon the improvement which can be made in finish durability if the designer of parts will keep in mind the limitations of plating, especially with regard to recessed areas. E. A. OLLARD (in discussion) comprehensively discussed plating of bearings and touched on the possibility of plating steel sheet for body use. A. W. WALLBANK (in discussion) showed how a small cost reduction of 8 per cent on a plated part resulted in a 98 per cent loss in the life of that part. Costs were analyzed further.

LYMAN B. SPERRY.

●

Pocket Set of Surface Finish Standards

ANON. *American Machinist* **90**, 162 (November 21, 1946).

A pocket set of standards for checking surface finish, which conforms to the "preferred-number" series of the American Standards Association, is announced by University Machine Company Division of Baird Associates, Cambridge, Mass. The set consists of 20 small blocks of stainless steel, each of which is machined to the surface finish specified for one of the standards. The finish of a part can be checked by drawing the finger nails across the specimen and across the standard. Designated University Type 7, the set is held in a Dow-metal case with the microinch reading and method of cut shown for each block.

●

Flame Fusing Protective Coatings

ANON. *Western Machinery and Steel World* **37**, 113–115 (July, 1946).

Minimum coat applied by Glaspray is about 6 ounces per square foot, but beyond this it can be piled on to any thickness. Chief advantages claimed are: comparative speed with which surfacing can be carried out; large areas and heretofore inaccessible surfaces can be coated; greater thickness can be applied in areas subjected to severe corrosive attack; wide variety of metals may be sprayed; and finer surface appearance.

●

Steel Phosphatizing

ANON. *Comptes Rendus de l'Academie des Sciences de l'URSS* **49**, No. 7; *Russian Research News* **1**, No. 3, 2 (review).

Intense wartime pressure forced Russian engineers to abandon the two-hour process which terminates when hydrogen generation stops. The internal strains set up within thick phosphate coatings produced by this technique practically negate their protective ability. Since phosphate coatings derive their protecting power from the thin, inner portion of the coat, a thirty-minute two-stage process was developed. The first stage consists of a ten-minute treatment in 30 to 32 g/l solution of iron and manganese phosphates at 96 to 98° C. A twenty-minute "impregnation" with an 8 to 10 per cent solution of chromium phosph. te at 80 to 90° C follows. After a successful test run of 30,000 pieces of steel, the process was adopted by a large factory.

Treatment of Magnesium in Chromic Solutions

J. FRASCH. *Metaux et Corrosion* **21**, 11–18 (January 1946); *Light Metals Res.* **8**, 7 (November 15, 1946).

Etching, chemical coating and galvanic coating of magnesium in solutions containing chromate or dichromate ions are discussed from the electrochemical point of view. Special reference is made to galvanic treatment of magnesium in acid solutions containing dichromate ions in association with manganese, aluminum, zinc, or chromium cations, and containing also a small amount of sulfate, phosphate, or nitrate anion. For the treatment a cell is formed by connecting the magnesium parts in the solution with, for example, a graphite plate which acts as a positive electrode.

The advantages of galvanic as compared with simple chemical treatment are that the solutions used are less corrosive, there is very little change in dimensions of the magnesium parts, thicker and more protective films are formed, and the solutions are much easier to maintain.

•

A High Ampere Capacity Sliding Contact

M. B. ANTRIM. *Iron and Steel Eng.* **23**, 108–109 (September 1946).

A high current capacity sliding contact has been developed for transferring high current to an object or machine moving in a straight line. It consists of a copper container holding a bath of mercury in which is suspended, in such a manner as to be separated from the container, an upper copper contact.

•

Porcelain Enamel Coating for Aluminum

J. F. MASON. *Iron Age* **158**, 60 (Aug. 15, 1946).

A brief note describing preparation of aluminum surfaces for enamels, types of enamels used and advantages of the coating.

Aluminum Pigments

ROBERT I. WRAY. *Org. Finishing* **7**, 18–22 (July, 1946).

Tables give comparative durability after nine years' exposure of two coats of aluminum paint made with aluminum pastes of different degrees of fineness and moisture impedance in different concentrations and film thicknesses.

•

Phosphating Metallic Surfaces—I, II and III

W. G. CASS. *Chemical Age* **55**, 5–8 (July 6, 1946); 35–38 (July 13, 1946); 67–70 (July 20, 1946).

Essentially a review of literature and patents on phosphating: preparation of the surface; preliminary cleaning; types of bath; factors for efficiency; use of sulfates; low temperature phosphating; inorganic and organic accelerators; catalysts; quality of coatings; influence of corrosive conditions; oil adsorption powers; renewal of baths; phosphating non-ferrous metals; special uses; aid to lubrication. A large number of references are given.

•

Titanium-Stabilized Iron for Enameling

EUGENE WAINER. *Am. Ceramic Soc. Bul.* **25**, 248–259 (July 15, 1946).

History of the art and science of vitreous enameling is presented. The enameling process is described and the various defects and presumed causes detailed, particularly the role of the base iron in the development of such defects. A discussion follows of the relative behavior of the carbides of iron and titanium in enameling stock, with particular emphasis on their relation to enamel defects. Manufacture of titanium-stabilized enameling iron, its properties, and its value for the development of a blemish-free one-coat finish are covered.

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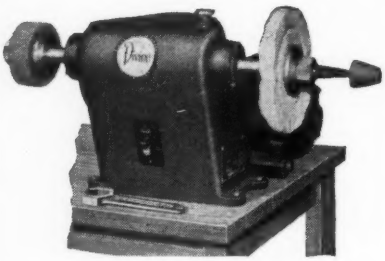

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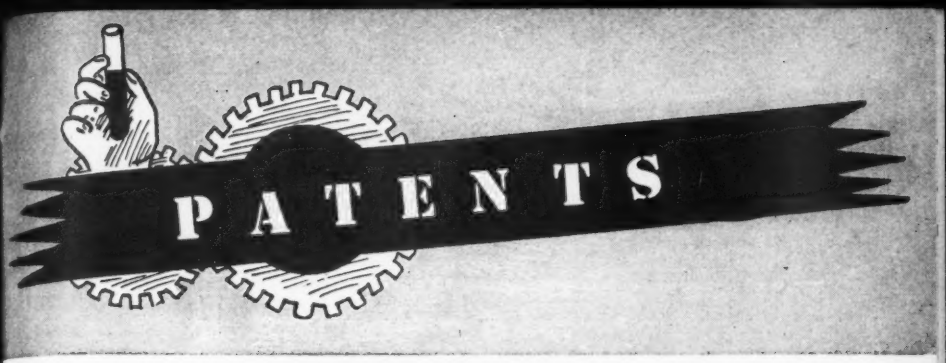

By GEORGE B. HOGABOOM
Consultant, New Britain, Conn.

No. 2,415,361, February 4, 1947—Method of Forming Engraved Markings in a Ferrous Article—C. W. Mell, assignor to Radio Corporation of America.

CLAIM 4. The method of forming engraved markings in a ferrous article which comprises first treating the surface of said article with a phosphate to form a coating of adherent iron phosphate thereon, then applying thereto a finishing coat of organic material capable of becoming cured to a hard, firm condition in the course of time and which in said condition, is insoluble in sodium cyanide solution, then causing said finishing coat to become cured in said condition, then cutting said markings through said finishing coat and into said article, then cleaning said markings with the aid of a solution of sodium cyanide, then applying thereto a coating of an adherent, stable metal capable of being electroplated with another metal, subsequently electroplating a coating of silver over said adherent metal coating, and finally covering said silver coated markings with a transparent protective coating.

No. 2,416,949, March 4, 1947—Cells for pH Measurements—George A. Perley and James B. Godshalk, assignors to Leeds and Northrup Company.

CLAIM 1. A cell for measuring the *p*H of a solution containing molecular oxygen and free of molecular hydrogen comprising in contact with the solution a non-porous iridium measuring electrode, uncontaminated by occluded hydrogen and whose voltage/*p*H characteristic is consistently reproducible and approximates that of the theoretical oxygen electrode.

CLAIM 8. A cell for measuring the *p*H of a solution containing molecular oxygen and free of molecular hydrogen, and containing ions of one or more of the metals copper, silver, lithium, sodium and potassium, comprising in contact with said solution a measuring electrode of iridium, non-porous and uncontaminated by occluded hydrogen, and whose voltage/*p*H characteristic, for current densities less than 10^{-7} ampere per square centimeter of area of contact with said solution and for a temperature of said solution from about 0° C to about 100° C, is consistently reproducible and linear from about plus .7 volt at 0 *p*H to about minus .1 volt at 14 *p*H.

No. 2,417,133, March 11, 1947—Electrodepositing and Heat-Treating Molybdenum-Oxygen Deposits—Ernest W. Schweikher, assignor to E. I. du Pont de Nemours & Company.

A bath for the production of colored molybdenum-oxygen electrodeposits was prepared having the following composition:

	Grams per liter
Boric acid, H_3BO_3	48
Sodium molybdate, Na_2MoO_4	22.5
Molybdic oxide, MoO_3	15
Nickel sulfate, $NiSO_4.6H_2O$	30
Sodium thiocyanate	3.8

The *p*H of the bath was 4.0. In use the bath was maintained at a temperature about 70° C. Nickel anodes and carbon

anodes were used to supply current to the bath.

In this bath a strip of cadmium-plated steel was used as a cathode at a current density of 4 amperes per square foot. The deposit so obtained was washed and dried and then treated according to a process of this invention by heating it to 200° C and maintaining it at this temperature for 5 minutes, after which it was allowed to cool. The deposit which had thus been treated was found to be remarkably resistant to abrasion and to chipping off by deformation of the base metal as by bending.

A molybdenum-oxygen deposit which was black in color was prepared as described above, the base metal employed as cathode being a strip of zinc-plated steel.

CLAIM 4. In a process for the production of an adherent, abrasion-resistant electrodeposit, the steps comprising electrodepositing a cathode deposit of an oxygen compound of molybdenum at a current density of about 1 to 15 amperes per square foot from an aqueous acid bath of *p*H 2.5 to 5.0, the bath including boric acid, nickel sulfate, and a soluble molybdenum compound selected from a group consisting of sodium molybdate, ammonium molybdate and molybdic acid, the amount of molybdenum present being from 7–150 grams per liter and from 1 to 5 times the amount of nickel, and heating the deposit in boiling water under normal atmospheric pressure for about five to fifteen minutes.

No. 2,417,203, March 11, 1947—Electroplating Nickel—Richard O. Hull and Raymond A. Hoffman, assignors to E. I. du Pont de Nemours & Co.

It is an object of the present invention to provide nickel plating compositions and processes of improved character. It is a further object of this invention to produce nickel deposits which are "smoother" than heretofore producible. It is still a further object of this invention to provide nickel plating compositions and processes which will quickly produce nickel deposits of great brightness. It is a still further object to provide electroplating baths of increased covering power and which produce nickel deposits of a desirable character over a wider range of current densities. It is a still further object of this invention to provide a levelling agent which may be added to a nickel plating bath to produce deposits of improved character. It is a still further object of this invention to provide nickel plating systems of high throwing power with respect to surface inequalities.

In order that the invention may be better understood, reference should be had to the following illustrative examples:

EXAMPLE I

A sulfurized proteinaceous material was first prepared. For this purpose one kilogram of glue was dissolved in five liters of water and to this solution was added one per cent of its weight of pancreatin. This solution was adjusted to a *p*H of 8.0 with ammonium hydroxide and was allowed to stand about eight hours at a temperature of about 40° C. Fifty grams of finely divided slaked lime and 100 cc. of carbon disulfide was added to the still warm solution and the whole agitated strongly for about two hours. The solution was then made slightly acid with dilute sulfuric acid and filtered to remove insoluble calcium sulfate. The product was then dried.

A nickel plating bath was made as follows:

	Grams per liter
Nickel sulfate ($NiSO_4.7H_2O$)	350
Nickel chloride ($NiCl_2.6H_2O$)	15
Boric acid (H_3BO_3)	35
Sulfurized proteinaceous material	0.1

EXAMPLE II

	Grams per liter
Nickel sulfate ($NiSO_4.7H_2O$)	350
Nickel chloride ($NiCl_2.6H_2O$)	15
Boric acid (H_3BO_3)	35
Orthosulfobenzaldehyde	5
Levelling agent (sulfurized proteinaceous material)	0.005

EXAMPLE III

	Grams per liter
Nickel sulfate ($NiSO_4.7H_2O$)	23
Nickel chloride ($NiCl_2.6H_2O$)	240
Boric Acid (H_3BO_3)	60
Metasulfobenzaldehyde	5
Sulfurized gelatine	0.005

(*Continued on page 601*)

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Here's proof—Place a small wad of steel wool in graduates filled with Diversey Everite and raw acid. Note how the steel wool is carried to the surface by bubbles of hydrogen released by the raw acid. In the Everite solution, the steel wool remains at the bottom . . . there's no evolution of hydrogen, no corrosion.

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1. **Reduces danger of hydrogen embrittlement.**
2. **Removes heat scale and rust quickly, completely, and safely without harming the sound metal. Will not change dimensions of forgings and castings.**
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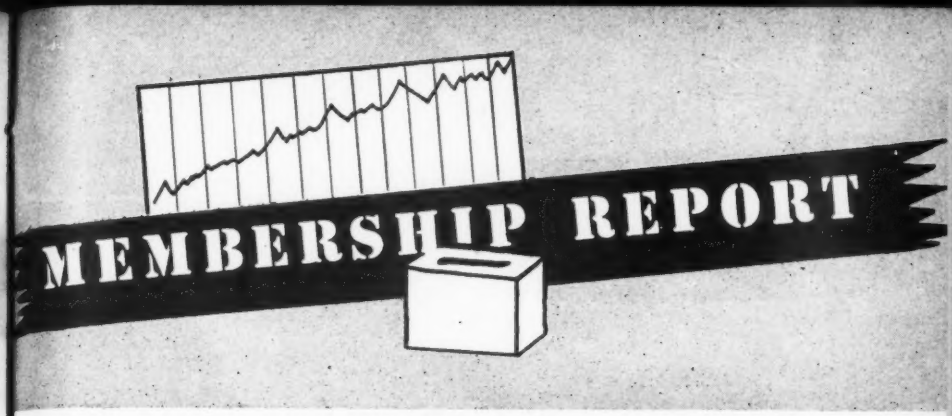

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R. Blades, 1840 N. Damen Ave., Chicago 47, Ill.

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A. M. Carlson, 5610 W. Ohio St., Chicago 44, Ill.

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M. D. Dougherty, 1849 Mohawk St., Chicago 14, Ill.

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Stuart M. Gastren, 849 Henrietta, Birmingham, Mich.

Paul R. Kenyon, 1027 Granger Ave., Ann Arbor, Mich.

Roscoe E. Lindsey, R. F. D. No. 2, Rochester, Mich.

Howard E. Morse, Jr., 4214 Balfour Rd., Detroit 24, Mich.

HARTFORD BRANCH

Martin H. Drumm, Jr., 475 Arch St., New Britain, Conn.

John E. McCullough, Sessions Clock Company, Forestville, Conn.

Harold L. Mitchell, 50 Washington St., Forestville, Conn.

Lincoln J. Murphy, P & W Aircraft, E. Hartford, Conn.

Salvatore P. Santoro, 1690 Main St., Hartford, Conn.

Leo J. Slominski, 839 Asylum Ave., Hartford, Conn.

NEWARK BRANCH

John P. Roos, 178 Renner Ave., Union, N. J.

NEW HAVEN BRANCH

Charles A. Bridgett, 1218 State St., New Haven, Conn.

William E. Bridgett, 848 E. Center St., Wallingford, Conn.

Walter P. Chandler, 45 Ward St., Wallingford, Conn.

Frederick W. Eppensteiner, 42 Fourth St., New Haven, Conn.

George R. Houk, 422 Third Ave., West Haven, Conn.

Edward L. Lick, 96 Wallace Row, Wallingford, Conn.

Herbert M. Moran, Lea Manufacturing Company, Waterbury 86, Conn.

James Taylor, 18 Mayflower Place, Milford, Conn.

Charles E. Williams, 848 Center St., Wallingford, Conn.

NEW YORK BRANCH

Edward M. Broniken, 1466 E. 49th St., Brooklyn 3, N. Y.

Harold S. Buttenheim, 146 E. 19th St., Brooklyn 26, N. Y.

George Chamalian, 1483 York Ave., New York 21, N. Y.

Frank Mazza, 2352 W. 13th St., Brooklyn 23, N. Y.

PHILADELPHIA BRANCH

Norman H. Hyam, 91 Erpingham Rd., Putney, London S. W. 15, England

Jack C. Rovaldi, 527 Fourth Ave., Haddon Heights, N. J.

Charles E. Salmon, Jr., 880 Marcella St., Philadelphia 24, Pa.

Charles G. Shute, Line Lexington, Bucks County, Pa.

Richard A. Weppner, 18 N. Lynnwood Ave., Glenside, Pa.

SAN FRANCISCO BRANCH

John Pessi, 1077 47th St., Oakland 8, Calif.

Kenneth W. Bivings, 2001 Allston Way, Berkeley, Calif.

Cecil K. Curtis, 1954 University Ave., Berkeley, Calif.

Ralph L. Ruggieri, 14100 E. 14th St., San Leandro, Calif.

SOUTHEASTERN BRANCH

Stanley D. McGregor, 1717 E. Lloyd St., Pensacola, Fla.

Herbert D. Metheny, General Electric Company, 400 Red Rock Building, Atlanta, Ga.

Edgar M. Rogers, 329 E. Kingston Ave., Charlotte, N. C.

Cyrus N. Shearer, Power Plating Inc., 115 Hines St., La Grange, Ga.

SPRINGFIELD BRANCH

J. Warren Gilchrest, 41 Dickinson Ave., Pittsfield, Mass.

James Laing, 93 Woodbridge St., South Hadley, Mass.

John H. Weir, 201 Britton St., Fairview, Mass.

SYRACUSE BRANCH

Franks Quackenbush, H. M. Quackenbush Company, Inc., Herkimer, N. Y.

WATERBURY BRANCH

William G. Bendokas, 364 Main St., Union City, Conn.

Francis T. Eddy, 173 Hillside Ave., Waterbury 20, Conn.

Lawrence D. Hooper, 144 W. Main St., Plantsville, Conn.

George F. Kelly, 305 Willow St., Waterbury 38, Conn.

John C. MacKellar, R. F. D. No. 1, Thomaston, Conn.

Louis M. Ursini, 21 Sandland Place. Waterbury 65, Conn.

REINSTATEMENTS

CINCINNATI BRANCH

J. B. Stace

PHILADELPHIA BRANCH

Edward Russell (former member of the Springfield Branch)

SYDNEY BRANCH

R. Veitch

TRANSFERS

D. Ward Hill from Buffalo Branch to Grand Rapids Branch
R. M. Fiandt from Chicago Branch to St. Joseph Valley Branch
C. L. Shaffer from Chicago Branch to St. Joseph Valley Branch
R. L. Thebaud from Chicago Branch to Detroit Branch
W. P. Goodwin from Cincinnati Branch to Columbus Branch
Louis Rague from Cincinnati Branch to St. Joseph Valley Branch
Russell Wiese from Cincinnati Branch to Dayton Branch
S. Senderoff from Detroit Branch to Baltimore-Washington Branch
Kasmir Jaros from New Haven Branch to Waterbury Branch
Joseph T. Sullivan from New Haven Branch to Boston Branch
Allen Brumm from Toledo Branch to Grand Rapids Branch

RESIGNATIONS

CHICAGO BRANCH
P. S. Springer

CINCINNATI BRANCH
Herman R. Engel
Frank P. Lester
Paul J. Seiwert

DETROIT BRANCH
R. D. McAleer
John S. Hicok

SUSPENSIONS

BALTIMORE-WASHINGTON BRANCH
Charles Allen Rice
Lindell L. Turner

DETROIT BRANCH
Thomas Mahoney
D. T. Stanton, Jr.

LOS ANGELES BRANCH
E. G. De Haas

MONTREAL BRANCH
F. Geoffre

ROCHESTER BRANCH
C. Barbero
S. Cipparucola
Judson R. Elster
Louis J. Hept
Leslie Knowlton
Michael F. Pavone
Elmore W. Turner

DEATHS

CHICAGO BRANCH
W. Bott

INDIANAPOLIS BRANCH
L. T. Nichols

SPRINGFIELD BRANCH
Raymond J. Degere

PATENTS

(*Continued from page 596*)

Baths similar to those of Examples II and III were made up but using instead of the orthosulfobenzaldehyde the following addition agents in the indicated amounts.

	Grams per liter
Methylnaphthalene sulfonic acid	1.5
Isopropylnaphthalene sulfonic acid	0.25
Naphthalene-2-5-disulfonic acid	2
Benzene sulfonic acid	5
Naphthalene sulfonic acid	1
Chloral hydrate	3

CLAIM. An aqueous nickel plating bath of the nickel sulfate-nickel chloride type in which the chloride anion and sulfate anion are in ratio of from 5:1 to 20:1 containing about 0.001 to 5.0 grams per litre of a bath-soluble sulfurized gelatin.

MEMBERSHIP CHART

BRANCH	Membership May 1, 1946	New Members	Net Change in Membership	Per Cent Net Change
FIRST GROUP				
PHILADELPHIA	170	55	+47½	+28.0
NEW YORK	201	55	+49½	+24.6
BRIDGEPORT	124	30	+26	+21.0
CHICAGO	359	65	+44½	+12.4
WATERBURY	128	16	+10½	+ 8.2
CLEVELAND	177	36	+14½	+ 8.2
HARTFORD	134	23	+ 7	+ 5.2
TORONTO	131	12	+ 6	+ 4.6
BOSTON	168	16	+ 6	+ 3.6
LOS ANGELES	181	30	+ 6	+ 3.3
NEWARK	243	21	+ 3½	+ 1.4
DETROIT	440	50	−18	− 4.1
SECOND GROUP				
PITTSBURGH	97	26	+25½	+26.3
GRAND RAPIDS	116	20	+19½	+16.8
INDIANAPOLIS	90	10	+12	+13.3
BUFFALO	87	10	+ 9	+10.3
BALTIMORE-WASH.	114	11	+ 6	+ 5.3
NEW HAVEN	110	11	+ 4½	+ 4.1
MILWAUKEE	120	15	+ 4½	+ 3.7
PROV.-ATTLEBORO	122	16	+ 4	+ 3.3
DAYTON	87	11	+ 2½	+ 2.9
ROCHESTER	97	4	− 6½	− 6.7
SPRINGFIELD	82	9	− 8	− 9.8
SYDNEY	82	11	−17	−20.7
ST. LOUIS	122	18	−26	−21.3
JACKSON-LANSING	85	4	−34½	−40.6
THIRD GROUP				
ST. JOSEPH VALLEY	60	19	+24	+40.0
ADELAIDE	37	12	+12	+32.5
TWIN CITY	72	27	+22½	+31.2
ROCKFORD	53	9	+ 9	+17.0
SYRACUSE	64	15	+ 9½	+14.8
SAN FRANCISCO	64	15	+ 6½	+10.2
COLUMBUS	34	5	+ 1	+ 2.9
MELBOURNE	69	..	+ 1	+ 1.7
LANCASTER	38	1	.....	.....
MONTREAL	61	8	− 1½	− 2.5
TOLEDO	60	2	− 4½	− 7.5
CINCINNATI	58	1	− 6	−10.3
TOTAL A. E. S.	4,527	743	+317	+ 7.0

Membership, April 10, 1947 4,844

Start with a *Good Finish*

Cleaning Compounds formulated by The Puritan Manufacturing Company provide platers with the necessary requirements for satisfactory plating. PURICO Compounds eliminate superfluous operations . . . save time and labor . . . minimize rejections . . . speeds up production.

Wonderbar

A pre-saponified Tripoli bar composition for economical buffing. Soluble in mild alkali, Wonderbar rinses from intricate patterns without requiring degreasing machines. *Makes tedious manual scrubbing unnecessary.*

Pur-Bur

Solves the tough and complex burring problem. Applied to the wheel, Pur-Bur is self-lubricating to prevent friction, embrittlement, or burned surfaces. Possesses high cutting qualities for rapid removal of burrs and fins without dangerous results.

Purico ZN

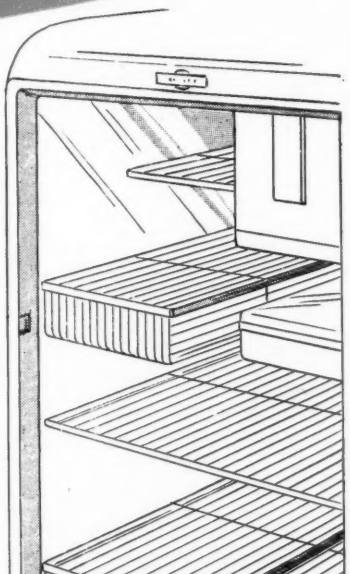
A black oxide finish that provides a lustrous black, long-lasting finish on Zinc products. Penetrates directly into the metal to eliminate the danger of chipping or flaking.

THE *Puritan*
MANUFACTURING COMPANY
WATERBURY, CONNECTICUT

A POST-WAR DECORATIVE PROTECTIVE FINISH

Pro-Seal

"TRADE MARK"



PRO-SEAL on **ZINC PLATE** brings up a grand Brilliance—inhibits and prevents white corrosion particles from forming for a considerably long period of time. While zinc is an ideal rust preventative—is cheap and easily applied electrolytically, its use has been limited for parts visible in final assembly because of dull and "dusty" corrosion products.

An adequate Zinc Plate plus Promat (non-electric) **PRO-SEAL** protects against **RUST** and makes any steel part **LUSTROUS, BRIGHT** and **ATTRACTIVE.**

PRO-SEAL is now specified and used to treat Zinc Plated Steel Refrigerator Shelves for a **MAJORITY** of domestic refrigerator manufacturers.

Hardware, automotive parts and hundreds of other fields can use **PRO-SEAL** to great advantage.

Distributors in principal cities—write to

PROMAT DIVISION—Poor & Company

851 SOUTH MARKET STREET WAUKEGAN, ILLINOIS

INDUSTRY NEWS

Job Shop Operations

The *Masters' Electroplating Association*, 123 William Street, New York 7, N. Y., in its *Monthly Bulletin* for March, advises that the rate of operation among its members was 62 per cent during the week ending March 8 and 59 per cent during the week ending March 22. This compares with 64 per cent during February and 76 per cent during January of this year, and 75½ per cent during March, 1946.

●

Electroplating Power Supply Booklet Published by Federal

Increased profit for electroplaters through the outstanding efficiency and economy of *Selenium Rectifier* DC power supplies is the subject of a new 24-page electroplating booklet published by *Federal Telephone and Radio Corporation*, manufacturing associate of *International Telephone and Telegraph Corporation*.

In addition to describing the economic and operational advantages of Selenium Rectifiers as a plating power supply, this new Federal publication contains a representative series of recommended plating room layouts, complete with diagrams and tables of required power equipment.

This booklet, as well as information on specific plating requirements, may be obtained upon request from Federal Telephone and Radio Corporation, 100 Kingsland Road, Clifton, N. J.

●

Wet Tumbling Abrasive

Alundum Abrasive is now being marketed by *Norton Company*, Worcester, Mass., in a special form for use for wet tumbling. It is a hard, heavy, tough and fast cutting aluminum oxide product that is proving excellent for cleaning, deburring, finishing and the development of radii on a wide variety of metal parts.

Alundum Abrasive is available in seven size groups. The extreme hardness of Alundum Abrasive provides continuous fast cutting action without glazing over as is often the case with other tumbling materials.

Precision parts are being consistently held to a one microinch finish by tumbling with Alundum Abrasive. Finishes with a higher micro reading than one, can be improved, it is stated.

●

Schroy Heads Columbia Rubber Sales

Appointment of *Robert L. Schroy* to direct sales activities of *Columbia Rubber Company*, Ravenna, Ohio, a division of *The U. S. Stoneware Company*, is announced by *Howard Farkas*, Executive Vice-President and General Sales Manager of U. S. Stoneware and its affiliated companies.

Mr. Schroy comes to Columbia from Firestone Tire and Rubber Company with whom he had been connected for some eleven years. He is a graduate of Miami University, Oxford, Ohio.

CLASSIFIED ADVERTISEMENTS

PLANT MANAGER

Established industrial chromium plating organization offers opportunity to man qualified through education, training and experience, as plant manager in midwest territory. Management experience essential; technical training desirable. State education, experience and other personal data.

Box MR-5A, The Monthly Review
P. O. Box 168, Jenkintown, Pa.

WANTED

One only sintering machine, continuous type. Advise size, type of conveyor, price, and where it can be inspected. Address:

MR-5B, The Monthly Review
P. O. Box 168, Jenkintown, Pa.

HELP WANTED

Man capable of taking charge of finishing departments, including buffing and all types of plating.

Please state past experience and salary expected.

Send replies to:

Box MR-5C, The Monthly Review
P. O. Box 168, Jenkintown, Pa.

INDUSTRIAL ENGINEER DESIRES POSITION

Young, ambitious, college trained engineer desires position utilizing his 13 years of experience in chemistry, metallurgy, methods, research, and development. Excellent knowledge of materials, processes, and equipment for foundry, electroplating and finishing, heat treating, welding and brazing. Supervisory and teaching experience. Will consider sales, field service, etc. No objection to traveling, but prefer New York area. Send replies to:

MR-5D, The Monthly Review
P. O. Box 168, Jenkintown, Pa.

POSITION WANTED

Young man, 34 years old, married, graduate of Purdue University, active A. E. S. member, desires position as plating and polishing foreman.

Chemist; experienced in all phases of plant operation; can control solutions, make setup, processes, control labor, make cost estimates, etc.

Prefer position in Indiana or Kentucky but will consider any midwest location.

Send replies to:

MR-5E, The Monthly Review
P. O. Box 168, Jenkintown, Pa.

SITUATION WANTED

Experienced chemist and plating shop foreman desires position in plating field offering good future.

Experience includes testing and maintenance of solutions, plating to specifications, chrome build-up for grinding down to size, Parkerizing and general plating. A. E. S. member.

Send replies to:

MR-5F, The Monthly Review
P. O. Box 168, Jenkintown, Pa.

WANTED

Foreman of Plating Room with knowledge of plating on die casting and steel in chrome, brass, copper, silver. Salary open. Prefer man with experience in oxidizing brass and steel stampings.

W. A. Kendall, P. O. Box 613
Winston-Salem, North Carolina

METAL FINISHER-CHEMIST AVAILABLE

British metal finisher, 37 years old, with 20 years' practical experience in electroplating of all metals, anodizing and dyeing, phosphating and other chemical finishes, including control, testing and development, seeks employment in the U. S.

Send replies to:

Mr. Frank Taylor, 113 Amberly Road, Bush Hill Park, Enfield, Middlesex, England.

J. C. Miller Company Announces New Chrome Rouge No. 8319

The *J. C. Miller Company*, Grand Rapids, Mich., announces a newly developed *Chrome Rouge*, designated as *Number 8319*.

This rouge excels in coloring prior to the application of a baked enamel or lacquered finish when it is desirable to remove highlights by buffing.

Reports from the field show several important advantages: the rouge produces a fast cut, high color, and presents extreme ease in removal of any burned chrome spots; the compatibility of the binder is such as to make cleaning after buffing totally unnecessary.

Adhesion of enamel to the buffed chrome surface is said to be much higher than when the surface is buffed with the usual chrome rouge followed by electrocleaning.

Full details are available from the manufacturer upon request.

●

New Rack Plant

Standard Plating Rack Company, Chicago, announces the opening of a branch at Fairlawn, N. J. This plant, under the direction of *J. F. Herr* and located at 22-02 Raphael Street, will serve the Middle Atlantic and New England States in the manufacture of insulated plating racks for all types of metal finishing. An expansion of the company's facilities for making sample racks in the Chicago plant is also reported.

●

Firm Price Policy on Steam Heating Specialties

The *James P. Marsh Corporation* of Chicago is one organization willing to take a firm stand against the inflationary trend of industrial pricing. In plain terms of guaranteed prices the Marsh management has declared a "firm price policy" in the sale of Marsh products such as pressure gauges, dial thermometers, packless valves, traps, vents and related steam heating specialties. Any prices of Marsh products quoted henceforth during 1947 will not be subject to any increase above the prices in effect on the date the order is placed, according to the announcement.

★ Lower Costs
★ Bright Deposits
★ Uniform Finish
★ Completely Soluble

"Neo-Brite" is a chemical discovery—a new formula—has all the high quality features of the highest priced zinc brighteners, yet *costs you less.* Users are finding "Neo-Brite" ideal for all zinc brightening in their production. One trial will prove its value to you. A sample will be sent upon request on your company stationery.

R. A. HOFFMAN CHEMICAL CO.
1734 Glenridge Rd. Euclid 17, Ohio

A RECTIFIER *for* EACH TANK

Better Work... Lower Costs

Greater flexibility in handling varying jobs from tank to tank is assured by the installation of an R-A Selenium Rectifier for each tank. The finest voltage settings for the most difficult job in each tank can be set without overall loss of power. The complete installation is economical too.

Richardson-Allen Selenium Rectifiers are a great advancement in current conversion, engineered and built for long hard service. All units are tested at 25% continuous overload before leaving the factory.

Standard units available for immediate delivery. Write us today for data bulletins and the name of your nearest dealer. He will be glad to give you comparative cost figures on installation and operation.

Consider These Advantages:

1. Continuously variable stepless voltage control sealed in oil.
2. No lag in starting.
3. Adaptable for remote control.
4. Constant efficiency with varying loads.
5. No standby losses when not under load.
6. Internal forced cooling.
7. Thermostatic protection.
8. Units operate in room temperature up to 105° F.
9. Switches and pilot light on both basic and remote control units.

Rectification for Every Application

RICHARDSON-ALLEN CORP.
15 WEST 20th STREET, NEW YORK 11, N. Y.
Sales Engineers Located in Principal Cities
Manufacturers of the most complete line of standard Selenium Rectifiers

RICHARDSON-ALLEN
Selenium Rectifiers

Richardson-Allen Offers Selenium Rectifier Catalogue

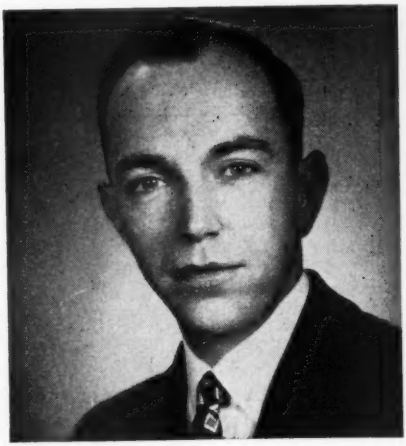
Richardson-Allen Corporation, 15 W. 20th Street, New York 11, N. Y., has published a new 12-page loose-leaf catalogue describing its lines of *selenium and tube rectifiers*.

A large range of sizes are available, including many "self contained" units with meters, stepless variable control from 0 to full load and shunt. Remote control units are motor controlled in sizes over 1000 amperes.

Write for your copy.

●

Martin Joins Engineering Staff of Enthone, Inc.



John J. Martin, Jr., has joined the engineering staff of *Enthone, Inc.*, 442 Elm Street, New Haven, Conn., to work on customers' service problems attendant with plating equipment and also to work on engineering design of plating equipment.

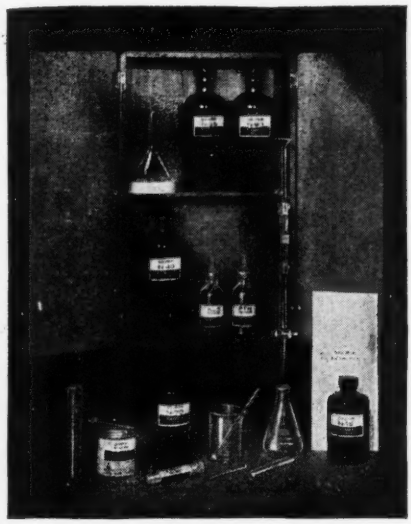
Mr. Martin received his degree in Mechanical Engineering from Yale University in 1940. He served in the Armed Forces for five years and left the service with the rank of Lt. Commander in the Submarine Service.

He is a member of the American Society of Mechanical Engineers and the Yale Engineering Society.

●

New Technical Periodical

To meet the insistent growing demand for more technical information on fabricating and processing aluminum in all its forms, *Reynolds Metals Company* has inaugurated



CHROMIUM
NICKEL
COPPER

Simple test sets for aid in controlling plating and other solutions.

Write for literature.

KOCOUR CO.

4801 S. ST. LOUIS AVE.
CHICAGO 32, ILL.

Specify Kocour Sets from your supplier.

FOR QUALITY AND UNIFORMITY
SPECIFY **HARRISON 4A PRODUCTS**

STAINLESS STEEL POLISHING COMPOUNDS
Faster Cutting—Increased Production—Economy

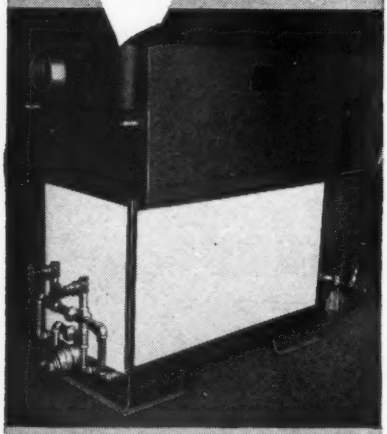
DOUBLE HEADER COMPOUNDS
Sizes: 150—180—220—240—320

COMPOUNDS FOR SPRAYING OR DIPPING
Use 4A Cement and Thinner Instead of Glue

Consult Us On Any of Your Problems
We'll Gladly Advise and Send Samples

HARRISON & CO. INC.
Haverhill, Mass.

CHECK ON THESE
D'OILER
PLUS ADVANTAGES!



1 EXPERIENCE-DESIGNED
2 JOB-ENGINEERED
3 ECONOMY OPERATED

FOR THOROUGH METAL CLEANING

The D'OILER Vapor Spray machine, illustrated above, can be used as a vapor-spray, or a straight vapor degreasing unit. Drain table recaptures dragout from basketed parts . . . all-around insulation reduces heat losses . . . exhaust duct on two sides safeguards operator . . . pump drive for standby solvent eliminates hand pouring.

Every D'OILER type is built to do a specific job . . . is designed with the "on-the-job experience" necessary to provide a degreaser that does the work, in the required volume, economically.

Our engineers will gladly advise on degreasing problems; your inquiries will receive prompt attention. Write today.

Mechanical
PROCESS COMPANY
P. O. BOX 88, SOUTH ORANGE, N. J.

a new service to the metalworking industries by establishing the *Technical Advisor*, a monthly technical paper devoted to publicizing latest recommendations on how to use aluminum mill products most effectively.

The periodical is sent free upon request to Technical Editorial Service, Reynolds Metals Company, 2500 S. Third Street, Louisville 1, Ky.

●

Lewis Joins U. S. Stoneware Process Equipment Division

Sidney A. Lewis, former Captain in the U. S. Army Chemical Warfare Service, has joined the *U. S. Stoneware Company's* Process Equipment Division's sales engineer force, according to an announcement by *Howard Farkas*, Stoneware's Executive Vice-President and General Sales Manager.

Mr. Lewis, an authority on electroplating on plastics, will make his headquarters at the New York office of U. S. Stoneware, 60 E. 42nd Street.

He is a member of the American Chemical Society, the Electrochemical Society, the American Electroplaters' Society, and holds the rank of Major in the U. S. Army Reserve.

●

Bulletin on Diaphragm Valves

Technical features are recounted and sizes given of Macalator Flexifram Valves in *Bulletin No. 112-B*, just published by *McAlear Manufacturing Division, Climax Industries, Inc.*, 1901 S. Western Avenue, Chicago 8, Ill.

Write for your copy.

For Sale

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Slightly Used

BUFFS

LOOSE & SEWED
ANY QUANTITY
ALL SIZES

•

Michigan Buff Co., Inc.

4054 BEAUFAIT AVE.
DETROIT (7) MICHIGAN

"YANKEE BRAND"

PROGRESSIVELY BETTER
ABRASIVE COMPOUNDS

Tailored to fit all
finishing requirements.

Inquiries respectfully solicited

★

E. E. SEELEY COMPANY

(est. 1919)
Manufacturers
BUFFING COMPOSITIONS
FOUNDRY FACINGS
900 Housatonic Ave., Bridgeport, Conn.
Tel. 5-0943

McKeon's

"Liquid Sulphur"
TRADE MARK REG'D.

"The Copper Strip of Today"

Non-Dangerous
Simple
Satisfactory
Service Free

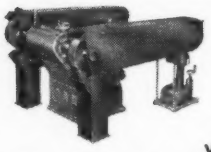
BOOTH 110
AES CONVENTION
DETROIT . . . JUNE 23 to 27

Sulphur Products Co. Inc.
Greensburg 9, Pa.

Hammond of KALAMAZOO

FINISHING PRODUCTION REACHES A NEW PEAK

HAMMOND
BACKSTANDS
CONVERT GRINDERS and POLISHERS
into high production
ABRASIVE BELT UNITS



MODEL No. 3

Above: "VRO" Polishing Lathe with two No. 3 Backstands.

WRITE FOR CATALOG 55 — covering complete line of Hammond equipment.

Hammond Machinery Builders
1613 DOUGLAS AVENUE, KALAMAZOO 54, MICH.

FOR SALE

Green Selectro-Platers 1800, 900 and 500 Amperes

Hammond Model SB-6 Rotary Buffer with four 4 HP heads

18" x 36" Industrial Filter

12" x 30" Crown Plating Barrel

Hammond 3RR Polishing Lathes

Motor Generators, 400 and 4000 Amperes

Weber Machinery Co.
1801 E. 21st St.
Cleveland 14, Ohio

Zialite

Reg. U. S. Pat. Off.

For NICKEL PLATING

The one bath especially designed for plating WHITE METAL ALLOYS including ZINC, LEAD and ALUMINUM.

FOR
HARD CHROMIUM
USE
Zialite
ADDITION AGENTS

Send a sample of your present bath to see if it is suitable for conversion to this improved formula.

ZIALITE CORPORATION
92 Grove Street
Worcester 5, Mass.

ACID AND ALKALI PROOF LININGS AND MORTARS

•

ACID PROOF CONSTRUCTION

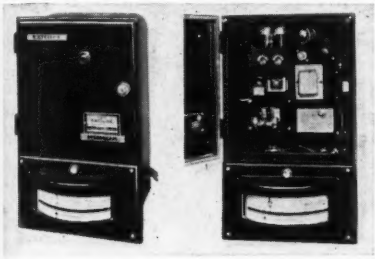
•

THE CEILCOTE CO.

Consulting and Research Engineers
750 ROCKEFELLER BLDG.
CLEVELAND, OHIO

Temperature Control Combines Features of Two Units

A new precision temperature-variation control instrument, the *Xactline Capacitrol*, has been announced by the *Claud S. Gordon Company*, 3000 S. Wallace Street, Chicago 16, Ill.



The new instrument combines in one complete unit all the outstanding features of the Claud S. Gordon Company's Xactline Control Unit and the Wheelco Instrument Company's Electronic Principle Capacitrol.

Completely descriptive literature available upon request.

Increased Caustic Soda Facilities

Total cost of the present plant modernization and expansion program of *The Mathieson Alkali Works* is now estimated at $9,500,000, according to *George W. Dolan*, President. This estimate does not include alteration of the recently acquired government ammonia plant at Lake Charles. The program which was started in 1945 will probably be completed in late 1947, it was stated. Production of caustic soda and soda ash, both of which are in critically short supply, will be substantially increased.

●

Plant Layout Models

A new business, *Triometric, Inc.*, Pittsburgh 12, Pa., has been started by *Richard Rimbach* for the production of three-dimensional precision scale models and templates which are used as a guide in setting up and rearranging the layout of industrial plants, warehouses and offices.

The company also offers a consulting service to assure that the plant design is adequate to meet production requirements and incorporates features needed for efficient operation.

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Carborundum Develops New Grinding Wheel

Several years were consumed in the development of the new *Series 20 Grinding Wheels* by the Technical Laboratories of *The Carborundum Company*, Niagara Falls, N. Y. In addition, thorough tests have been made under a diversity of production conditions in many factories.

Seven important advantages of Series 20 are claimed: Faster stock removal, less grinding labor hours, fewer damaged tools (less scrap), longer tool life (between grinds), less heat generation, better tool finishes, and smaller inventories.

●

Honeywell-Brown Open New Office

Minneapolis-Honeywell Regulator Company and its industrial division, *Brown Instrument Company*, Philadelphia, have opened a district office at 27 Halstead Street, East Orange, N. J., manned by six Honeywell and five Brown sales and service engineers.

Data on Caustics

Attractive folders on Caustic Soda, Soda Ash, Caustic Ash, and Columbia Cleaner and Cleanser may be had by writing to *Pittsburgh Plate Glass Company, Columbia Chemical Division*, Fifth Avenue at Bellefield, Pittsburgh 13, Pa.

●

"Finishes for Aluminum" Described by Reynolds

To indicate some of the important possibilities, *Reynolds Metals Company* has published "*Finishes for Aluminum*" in two volumes.

The first book, Section One, is wire bound and contains 108 pages devoted to 8 cleaning treatments, 17 mechanical surface finishes, 15 chemical surface finishes, 11 electrolytic oxide treatments, 12 electroplated coatings, 7 paint application methods, 7 paint coatings, ceramic coatings (vitreous enamels), special finishes such as silk screen and sprayed metal finishes, and concludes with a discussion of various controls and tests for finishes.

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The second book, Section Two, supplements this information with 120 pages of shop data on materials, equipment, solution preparation, procedure and control for more than 30 of the most widely used finishing processes. This book is supplied in a separate loose-leaf binder and new and revised bulletins will be issued at intervals to keep the information up-to-date.

Reynolds' "*Finishes for Aluminum*" (two volumes) thus supplies to users of aluminum a continuing service unique in the finishing field. It offers an effective means of keeping up with the many advances being made in this phase of aluminum processing. Copies are available from Reynolds Metals Company, Dept. 27, 2500 S. Third Street, Louisville 1, Ky. Price, $2.00.

•

Instruments for Immediate Delivery

A new Bulletin listing over 150 different items maintained in stock for immediate delivery has been published by *The Bristol Company*, manufacturers of recording and controlling instruments for industrial processes. The new *Bulletin No. W1811* lists recording thermometers, pyrometers, pressure gauges, voltmeters, ammeters, and *p*H recorders. Also listed are recording controllers, indicating controllers, miscellaneous instruments, and accessories.

Copies of Stock Instruments *Bulletin W1811* are available from The Bristol Company at Waterbury 91, Conn.

New Rubber Bucket Catalogue Section

A new four-page catalogue section on its Flexite rubber pouring buckets and dippers, used for the safe and economical handling of acids, corrosives, liquid explosives and many other highly active liquids, has been published by *The B. F. Goodrich Company*, Akron, Ohio, and can be obtained upon request.

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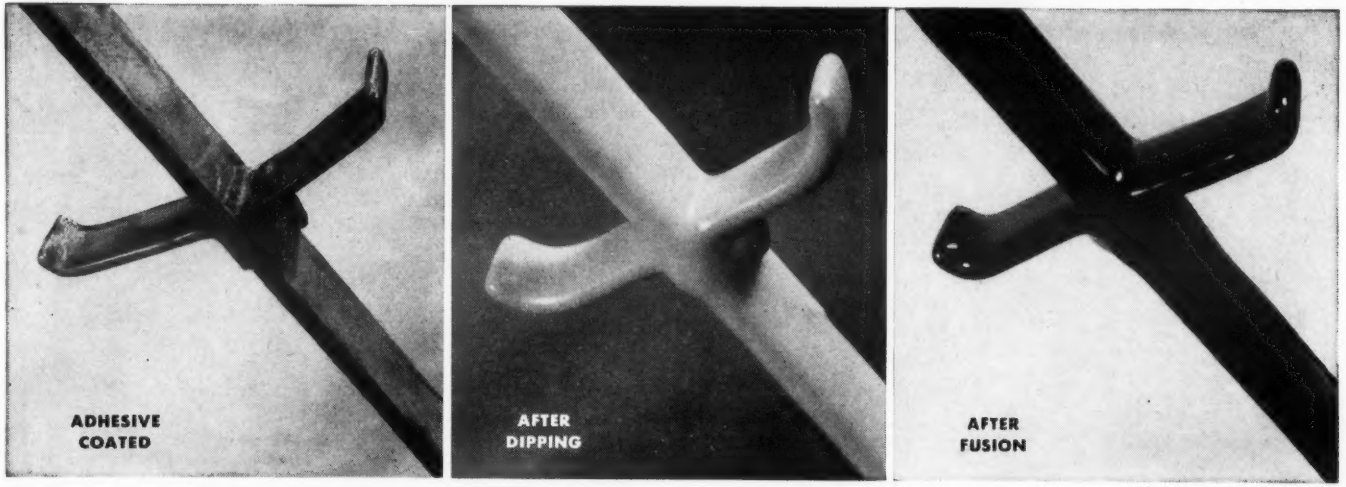

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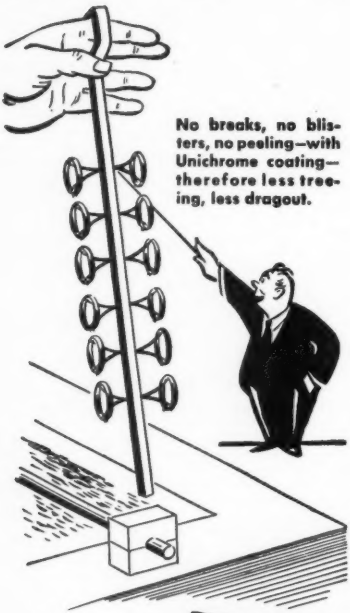

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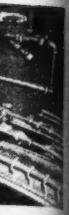

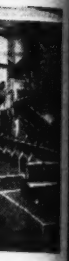

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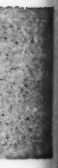

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